A52942

SWR BRIDGES AND AUTOTESTERS
INSTRUCTION MANUAL

97A50

WILTRON

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MODEL 97A50 SWR Bridge

SPECIFICATIONS

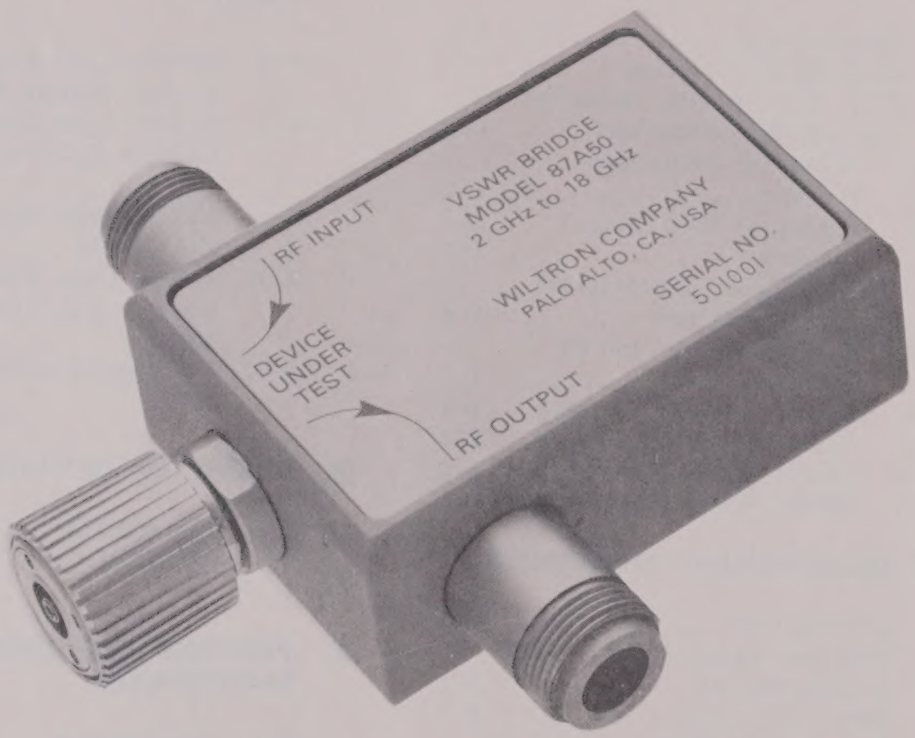
The Model 97A50 SWR Bridge supplied with this order meets the following specifications:

Frequency Range:	10 MHz to 18 GHz
Directivity:	36 dB minimum
Frequency Sensitivity:	±1.5 dB maximum
Accuracy: Measured SWR is accurate to within:	$.016 \pm .06\rho^2$ 10 MHz to 8 GHz; $.016 \pm .10\rho^2$ 8 GHz to 18 GHz (where ρ is the reflection coefficient being measured).
Input Connector:	Type N Female, Stainless Steel
Detector Output Polarity:	Negative
Detector Output Connector:	BNC Female
SWR Output Time Constant:	2 microseconds
Insertion Loss:	6.5 dB nominal (from input to test port)
Maximum Power Input:	.5 Watt
Weight:	14 oz. (400 g.)
Dimensions:	3" x 2" x 1-1/8" (7.6 x 5 x 2.8 cm.), excluding connectors

TABLE OF CONTENTS

Section		Page
I	**GENERAL INFORMATION**	
1-1	Introduction	1-1
1-2	General Description	1-1
1-3	SWR Autotesters, Description and Specifications	1-1
1-3.1	Series 63 SWR Autotesters	1-1
1-3.2	Series 67 SWR Autotesters	1-1
1-4	SWR Bridges, Description and Specifications	1-4
1-4.1	Series 60, 64, and 65 SWR Bridges	1-4
1-4.2	Series 68 SWR Bridges	1-4
1-4.3	Series 62 SWR Bridges	1-4
1-4.4	Model 69A50 SWR Bridge.	1-4
1-4.5	Model 87A50 SWR Bridge.	1-4
II	**SWR MEASUREMENT TECHNIQUES**	
2-1	Introduction	2-1
2-2	SWR and Related Measurements	2-1
2-3	SWR Graticules	2-1
2-4	Accuracy of SWR Measurements	2-1
2-4.1	Accuracy Limitations When Measuring a Small SWR	2-3
2-4.2	Accuracy Limitations When Measuring a Large SWR	2-3
2-4.3	Type N Precision Connectors	2-3
2-4.4	RF Leveling	2-3
2-4.5	Calibrated Mismatch	2-3
2-5	SWR and Return Loss Measurement Procedures	2-4
2-6	SWR Measurements Using Graticules	2-4

Section		Page
II	**SWR MEASUREMENT TECHNIQUES (Con't)**	
2-7	Return Loss Measurement Using a Known Attenuation	2-6
2-8	Return Loss Measurement Using a Calibrated Mismatch	2-8
2-9	SWR Measurement at Low RF Levels	2-8
2-10	Return Loss Measurements Using a Logarithmic Level Meter	2-9
2-11	RF Measurement Chart	2-9
III	**THEORY OF OPERATION**	
3-1	Introduction	3-1
3-2	Description	3-1
IV	**PERFORMANCE CHECK AND MAINTENANCE**	
4-1	Introduction	4-1/4-2
4-2	Directivity Check (Balance of Bridge or Autotester)	4-1/4-2
4-3	Autotester Output Check	4-1/4-2
4-4	Maintenance	4-1/4-2
V	**ACCESSORIES**	
5-1	General	5-1
VI	**SWR NOMOGRAPHS**	
6-1	General	6-1



Typical SWR Bridge
(Model 87A50 shown)

SECTION I

GENERAL INFORMATION

1-1 INTRODUCTION

This instruction manual describes the WILTRON Series 63 and 67 SWR Autotesters, and the Series 60, 62, 64, 65, 68, 69, and 87 SWR Bridges. Section 1 of the manual contains a description and specifications for each series. Section II provides SWR measurement procedures using the autotesters and bridges. Section III provides a brief theory of operation and Section IV contains performance verification and maintenance instructions. Useful accessories for the SWR autotesters and bridges are described in Section V.

1-2 GENERAL DESCRIPTION

The WILTRON SWR Bridges and Autotesters are devices used with other test instruments for making fixed or swept-frequency standing wave ratio (SWR) or return loss measurements over a wide frequency range. SWR measurements are made to check the performance of RF components such as amplifiers, directional couplers, attenuators, filters, splitters, and terminations.

The SWR autotesters and bridges offer significant advantages over such SWR measuring devices as slotted lines, dual directional couplers, and reflectometers. The autotesters and bridges provide greater accuracy for both null (balanced) and unbalanced conditions. Simpler and more accurate calibration is possible by using a calibration attenuator between the RF source and the autotester or bridge input. This eliminates the need for a calibrated mismatch at the test port and the resulting SWR error of the mismatch input connector. In addition, the autotesters and bridges do not require a modulated RF source to make the SWR measurement.

Basically, the SWR autotesters and bridges are precision balanced Wheatstone bridges. Both devices have an internal precision reference termination which is part of the bridge. The autotesters also have an internal RF detector which is not included in the bridges. Because of the internal RF detector the autotester is the more complete test device and the simplest to use. However, the SWR bridge provides greater flexibility if additional RF amplification is required (for low level SWR measurements) or if the bridge output is to be applied to a network analyzer or other signal processing equipment. When an external detector is connected to the 'RF OUT' connector of a bridge, the operation is identical to that of the autotester.

1-3 SWR AUTOTESTERS, DESCRIPTION AND SPECIFICATIONS

1-3.1 SERIES 63 SWR AUTOTESTERS

The Series 63 SWR Autotesters provide the highest performance and widest bandwidth (up to 4 GHz). Typical directivity is better than 43 dB and accuracy is typically $0.0075 \pm 0.03\rho^2$ (where ρ is the reflection coefficient being measured). A precision Type N test port connector is usually supplied. Other connector types are also available. Table 1-1 lists those specifications which apply to all Series 63 SWR autotesters. Additional specifications for individual models are provided in Table 1-2.

Table 1-1. Series 63 General Specifications

ACCURACY: $0.01 \pm 0.06\rho^2$ (where ρ = reflection coefficient being measured).
OUTPUT POLARITY: Negative.
OUTPUT TIME CONSTANT: 2 microseconds.
INSERTION LOSS (from input to test port): 6 dB nominal.
MAXIMUM POWER INPUT: 1/2 watt.
INPUT CONNECTOR: Type N female, stainless steel.
DETECTOR OUTPUT CONNECTOR: BNC female.
WEIGHT: 12 ounces.
DIMENSIONS: 2 5/8" x 2" x 1", excluding connectors.

Table 1-2. Series 63 Model Specifications

MODEL NO.	FREQUENCY RANGE (MHz)	INPUT IMPEDANCE (ohms)	DIRECTIVITY[1] (dB)	TEST PORT CONNECTOR TYPE
63N50	10-4000	50	40	Type N Male
63NF50	10-4000	50	40	Type N Female
63S50	10-4000	50	36	SMA Male
63SF50	10-4000	50	36	SMA Female[2]
63G50	10-4000	50	40	GR 900
63A50	10-4000	50	40	APC 7
63N75	10-2000	75	40	Type N Male
63NF75	10-2000	75	40	Type N Female

(1) 46 dB directivity available as Option 1 except for Models 63S50 and 63SF50. Accuracy: $0.005 \pm 0.06\ \rho^2$.

(2) The 63SF50 uses a male output connector plus a male to female adaptor because the Type SMA female connector has a limited lifetime.

1-3.2 SERIES 67 SWR AUTOTESTERS

The Series 67 SWR Autotesters are low cost devices with good accuracy and directivity over a bandwidth of 10 to 1000 MHz. A variety of connector types are available for this series. Table 1-3 lists the specifications which apply to all Series 67 Autotesters. Table 1-4 lists the specifications for individual models of the series.

Table 1-3. Series 67 General Specifications

FREQUENCY RANGE: 10 to 1000 MHz.
ACCURACY: 0.01 ±0.1 ρ^2 (where ρ = reflection coefficient being measured).
DIRECTIVITY: 40 dB.
OUTPUT POLARITY: Negative.
OUTPUT TIME CONSTANT: 2 microseconds.
INSERTION LOSS (from input to test port): 6 dB nominal.
MAXIMUM POWER INPUT: 1/2 watt.
INPUT CONNECTOR: Type N female, or BNC female.
DETECTOR OUTPUT CONNECTOR: BNC female.
WEIGHT: 6 ounces.
DIMENSIONS: 2 1/4" x 1 3/8" x 1 1/8" excluding connectors.

Table 1-4. Series 67 Model Specifications

MODEL NO.	INPUT IMPEDANCE (ohms)	TEST PORT CONNECTOR TYPE
67N50	50	Type N Male
67NF50	50	Type N Female
67B50	50	BNC Male
67BF50	50	BNC Female
67T50	50	TNC Male
67TF50	50	TNC Female
67N75	75	Type N Male
67NF75	75	Type N Female
67B75	75	BNC Male
67BF75	75	BNC Female
67T75	75	TNC Male
67TF75	75	TNC Female
67FF75	75	Type F Female

1-4 SWR BRIDGES, DESCRIPTION AND SPECIFICATIONS

1-4.1 SERIES 60, 64, AND 65 SWR BRIDGES

The Series 60, 64, and 65 SWR Bridges are designed for high accuracy SWR measurements over wide bandwidths. The Series 60 SWR Bridges have a bandwidth of 5 to 2000 MHz. The Series 64 SWR Bridges cover a frequency range of 3 to 8 GHz (with Option 2 from 2 to 8 GHz). The Series 65 SWR Bridges, covering the frequency range of 7 to 12.4 GHz (with Option 2 from 4 to 12.4 GHz), are intended for use with X band equipment. Table 1-5 lists the specifications common to the Series 60, 64, and 65 SWR Bridges. Table 1-6 provides additional specifications for the individual models within each series.

Table 1-5. Series 60, 64, and 65 General Specifications

INPUT IMPEDANCE: 50 ohms.
INSERTION LOSS (from input to test port): 6.5 dB nominal
MAXIMUM POWER INPUT: 1/2 watt.
INPUT AND OUTPUT CONNECTORS: Type N female, stainless steel.

1-4.2 SERIES 68 BRIDGES

The Series 68 SWR Bridges have the highest directivity and lowest test port SWR, and are intended for use with HF communications, baseband, or video equipment. Specifications for the series are listed in Table 1-7.

1-4.3 SERIES 62 SWR BRIDGES

The Series 62 SWR Bridges are general purpose, low cost devices that are available in a variety of connector types and with a 50- or 75-ohm impedance. The Model 62 Series covers a frequency range of 10 to 1000 MHz. Complete specifications for the series are provided in Tables 1-8 and 1-9 at the end of this section.

1-4.4 MODEL 69A50 SWR BRIDGE

The Model 69A50 SWR Bridge operates over a frequency range of 8.0 to 18.0 GHz to cover both the X and Ku bands. Specifications for the Model 69A50 are listed in Table 1-10 below.

Table 1-10. Model 69A50 Specifications

FREQUENCY RANGE: 8.0 to 18.0 GHz.
ACCURACY: $0.018 \pm 0.12\rho^2$ (where ρ = reflection coefficient being measured).
DIRECTIVITY: 35 dB.
INPUT IMPEDANCE: 50 ohms.
INSERTION LOSS (from input to test port): 6.5 dB nominal.
MAXIMUM POWER INPUT: 1/2 watt.
INPUT AND OUTPUT CONNECTORS: Type N female, stainless steel.
TEST PORT CONNECTOR: APC 7, precision stainless steel.
WEIGHT: 12 ounces.
DIMENSIONS (excluding connectors): 2-7/8" x 2" x 1-1/8"

1-4.5 MODEL 87A50 SWR BRIDGE

The Model 87A50 is a broadband SWR bridge which covers a frequency range of 2 to 18 GHz. Directivity is typically better than 38 dB. Table 1-11 below lists the specifications for the Model 87A50.

Table 1-11. Model 87A50 Specifications

FREQUENCY RANGE: 2.0 to 18.0 GHz.
ACCURACY: $0.18 \pm 0.31p^2$ from 2 to 3 GHz
$0.18 \pm 0.2p^2$ from 3 to 4 GHz
$0.18 \pm 0.12p^2$ from 4 to 18 GHz.
(where p = reflection coefficient being measured).
DIRECTIVITY: 35 dB.
INPUT IMPEDANCE: 50 ohms.
INSERTION LOSS (from input to test port): 6.5 dB nominal.
MAXIMUM POWER INPUT: 1/2 watt.
INPUT AND OUTPUT CONNECTORS: Type N female, stainless steel.
TEST PORT CONNECTOR: APC 7, precision stainless steel.
WEIGHT: 12 ounces.
DIMENSIONS (excluding connectors): 2 5/8" x 2" x 7/8".

Table 1-6. Series 60, 64, and 65 Model Specifications

MODEL	FREQUENCY RANGE	ACCURACY	DIRECTIVITY	TEST PORT CONNECTOR	WEIGHT (Ounces)	DIMENSIONS (Excluding Connectors)
60N50	5 MHz to 2 GHz	$0.01 \pm 0.09\ \rho^2$	40 dB(1)	Type N Male	12	2-5/8" x 2" x 1"
60NF50	5 MHz to 2 GHz	$0.01 \pm 0.09\ \rho^2$	40 dB(1)	Type N Female	12	2-5/8" x 2" x 1"
60S50	5 MHz to 2 GHz	$0.01 \pm 0.09\ \rho^2$	40 dB	SMA Male	12	2-5/8" x 2" x 1"
60SF50	5 MHz to 2 GHz	$0.01 \pm 0.09\ \rho^2$	40 dB	SMA Female(6)	12	2-5/8" x 2" x 1"
60G50	5 MHz to 2 GHz	$0.01 \pm 0.09\ \rho^2$	40 dB(1)	GR 900	12	2-5/8" x 2" x 1"
60A50	5 MHz to 2 GHz	$0.01 \pm 0.09\ \rho^2$	40 dB(1)	APC 7	12	2-5/8" x 2" x 1"
64A50	3 to 8 GHz(4)	$0.016 \pm 0.12\ \rho^2$	36 dB(2)	APC 7	10	2-7/8" x 2" x 1-1/8"
64G50	3 to 8 GHz(4)	$0.016 \pm 0.12\ \rho^2$	36 dB	GR 900	10	2" x 2-1/2" x 1-1/4"
65A50	7 to 12.4 GHz(5)	$0.016 \pm 0.12\ \rho^2$	36 dB(3)	APC 7	10	2-7/8" x 2" x 1-1/8"

(1) 46 dB directivity available as Option 1. Accuracy: $0.005 \pm 0.09\ \rho^2$.
(2) 42 dB directivity available as Option 1 (3 to 8 GHz). Accuracy: $0.008 \pm 0.12\ \rho^2$.
(3) 40 dB directivity available as Option 1 (7 to 12.4 GHz). Accuracy: $0.01 \pm 0.12\ \rho^2$.
(4) 2 to 8 GHz frequency range available as Option 2. Accuracy, 2 to 3 GHz: $0.016 \pm 0.16\ \rho^2$.
(5) 4 to 12.4 GHz frequency range available as Option 2. Accuracy, 4 to 7 GHz: $0.016 \pm 0.16\ \rho^2$.
(6) SMA male with female adaptor.

Table 1-7. Series 68 Model Specifications

MODEL	FREQUENCY RANGE	ACCURACY*	DIRECTIVITY	INPUT IMPEDANCE (ohms)	INSERTION LOSS	MAXIMUM POWER INPUT	INPUT & OUTPUT CONNECTORS	TEST PORT CONNECTOR	WEIGHT (Ounces)	DIMENSIONS (Excluding Connectors)
68B50	50 KHz to 32 MHz	$0.003 \pm 0.07\rho^2$	50 dB	50	3.5 dB	1/2 watt	BNC Female	BNC Male	6	2-1/4" x 1-3/8" x 1-1/8"
68BF50	50 KHz to 32 MHz	$0.003 \pm 0.07\rho^2$	50 dB	50	3.5 dB	1/2 watt	BNC Female	BNC Female	6	2-1/4" x 1-3/8" x 1-1/8"
68T50	50 KHz to 32 MHz	$0.003 \pm 0.07\rho^2$	50 dB	50	3.5 dB	1/2 watt	BNC Female	TNC Male	6	2-1/4" x 1-3/8" x 1-1/8"
68TF50	50 KHz to 32 MHz	$0.003 \pm 0.07\rho^2$	50 dB	50	3.5 dB	1/2 watt	BNC Female	TNC Female	6	2-1/4" x 1-3/8" x 1-1/8"
68B75	50 KHz to 32 MHz	$0.003 \pm 0.07\rho^2$	50 dB	75	3.5 dB	1/2 watt	BNC Female	BNC Male	6	2-1/4" x 1-3/8" x 1-1/8"
68BF75	50 KHz to 32 MHz	$0.003 \pm 0.07\rho^2$	50 dB	75	3.5 dB	1/2 watt	BNC Female	BNC Female	6	2-1/4" x 1-3/8" x 1-1/8"
68T75	50 KHz to 32 MHz	$0.003 \pm 0.07\rho^2$	50 dB	75	3.5 dB	1/2 watt	BNC Female	TNC Male	6	2-1/4" x 1-3/8" x 1-1/8"
68TF75	50 KHz to 32 MHz	$0.003 \pm 0.07\rho^2$	50 dB	75	3.5 dB	1/2 watt	BNC Female	TNC Female	6	2-1/4" x 1-3/8" x 1-1/8"

*Accuracy from 50 kHz to 100 kHz is $0.003 \pm 0.11\rho^2$.

Table 1-8. Series 62 General Specifications

FREQUENCY RANGE: 10 to 1000 MHz.
ACCURACY: $0.01 \pm 0.12\rho^2$ (where ρ = reflection coefficient being measured).
DIRECTIVITY: 40 dB.
INSERTION LOSS (from input to test port): 6.5 dB nominal.
MAXIMUM POWER INPUT: 1/2 watt.
INPUT CONNECTOR: Type N female, or BNC female.
DETECTOR OUTPUT CONNECTOR: Type N female.
WEIGHT: 6 ounces.
DIMENSIONS: 2 1/4" x 1 3/8" x 1 1/8" excluding connectors.

Table 1-9. Series 62 Model Specifications

MODEL NO.	INPUT IMPEDANCE (ohms)	TEST PORT CONNECTOR TYPE
62N50	50	Type N Male
62NF50	50	Type N Female
62B50	50	BNC Male
62BF50	50	BNC Female
62N75	75	Type N Male
62NF75	75	Type N Female
62B75	75	BNC Male
62BF75	75	BNC Female
62FF75	75	Type F Female

SECTION II

SWR MEASUREMENT TECHNIQUES

2-1 INTRODUCTION

This section of the manual describes how an SWR autotester or bridge is used to make swept-frequency SWR measurements. The autotester or bridge is normally used with a suitable RF sweep generator, calibration attenuator, and an oscilloscope to form the basic SWR measurement test set-up. Other test devices such as a logarithmic level meter, linear RF amplifier, external RF detector, or calibrated mismatch are employed for certain SWR measurements. The use of these test devices is also described in this section.

2-2 SWR AND RELATED MEASUREMENTS

SWR is related to other performance measurements such as return loss, reflection coefficient, percentage of transmitted or reflected power, and transmission loss in dB. Conversion of SWR to these measurements, or vice versa can easily be made using the nomographs provided at the end of this manual.

2-3 SWR GRATICULES

A plastic sheet containing six graticules is supplied with each autotester or bridge. The graticules may be cut out to fit the oscilloscope used. The top calibration line on the graticule represents an SWR of 1.0, and the bottom line the maximum SWR for the range being used (see Figures 2-1 through 2-6). Some graticules may be marked VSWR instead of SWR. In either case, the ratio is the same.

NOTE

The graticules are accurate only when the RF detector is operated in the square law region (i.e. up to -18 dBm input to the detector).

2-4 ACCURACY OF SWR MEASUREMENTS

The accuracy of SWR measurements using the swept-frequency technique is dependent upon the following factors:

1. Inherent directivity (or balance) and output SWR of the autotester or bridge.
2. Output level and degree of leveling of the RF sweep generator.
3. Inherent SWR of test connectors and connector adapters.

To ensure accurate measurements, the test equipment should have the following characteristics:

1. RF sweep generator with a leveled output of 0.5 to 1V rms or more. Leveling should be uniform over the whole frequency band.
2. Oscilloscope vertical sensitivity of 1mV per cm or greater.
3. SWR autotester or bridge directivity of 35 dB or greater.
4. Test cables of the correct characteristic impedance to match the RF sweep generator, SWR bridge, and the device under test.

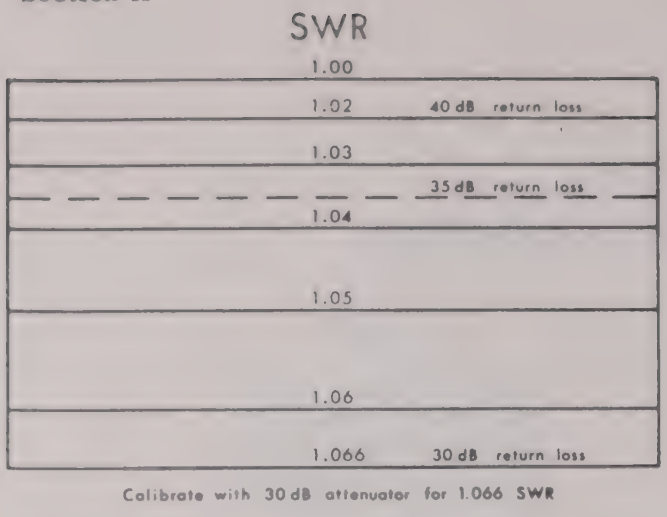


Figure 2-1. Graticule for SWR Values Between 1.00 and 1.066

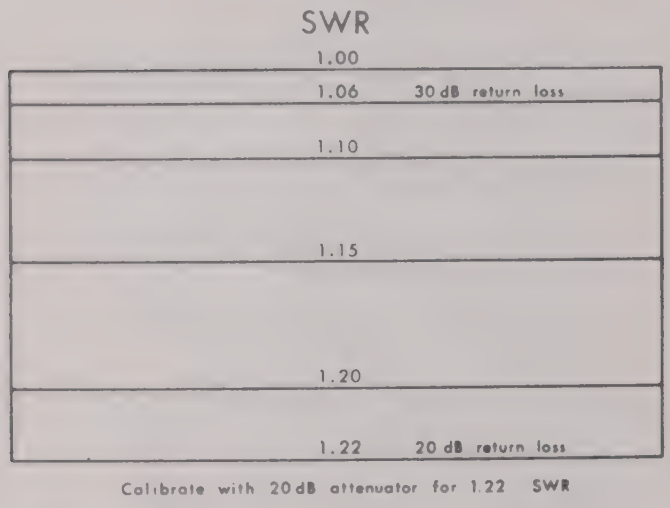


Figure 2-2. Graticule for SWR Values Between 1.00 and 1.22

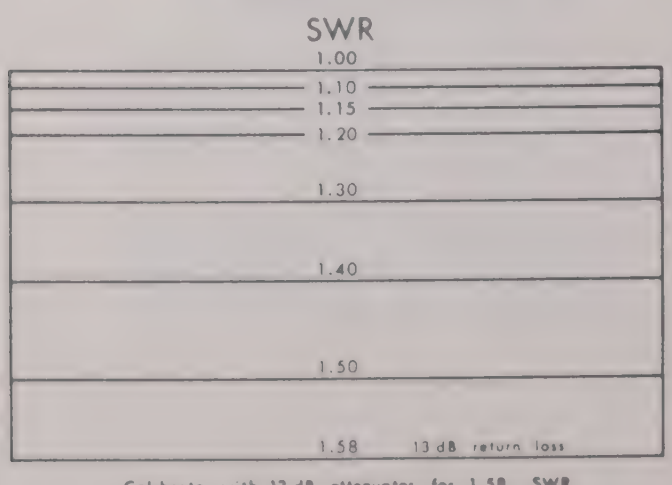


Figure 2-3. Graticule for SWR Values Between 1.00 and 1.58

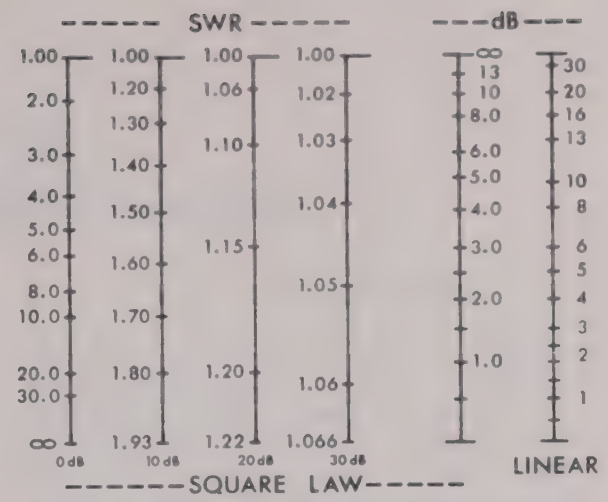


Figure 2-4. Graticule Selection Guide

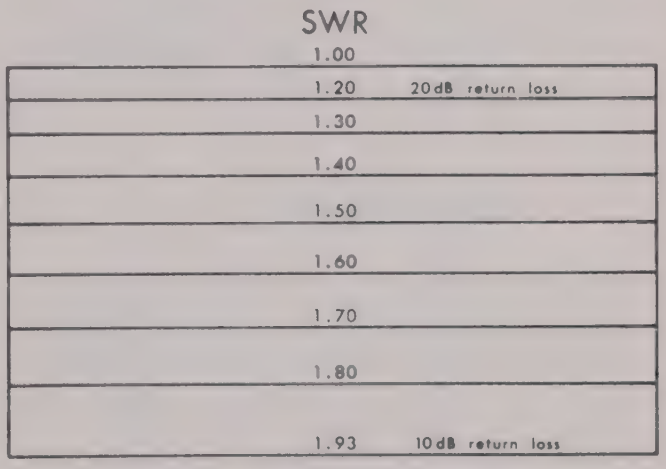


Figure 2-5. Graticule for SWR Values Between 1.00 and 1.93

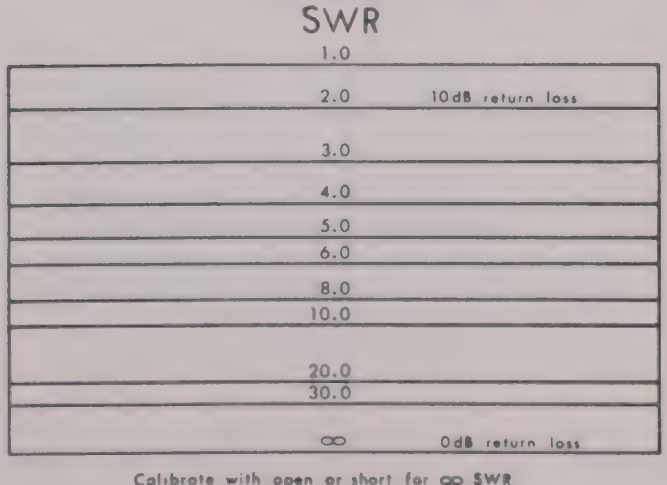


Figure 2-6. Graticule for SWR Values Between 1.0 and ∞

2-4.1 ACCURACY LIMITATIONS WHEN MEASURING A SMALL SWR

The theoretical limit of accuracy of an SWR autotester or bridge when measuring a small SWR is its inherent directivity or balance. For example, if an SWR bridge with an inherent directivity of 40 dB (equal to an SWR or 1.02) was being used to measure a device with an SWR of 1.2, the reading would range between 1.18 and 1.22.

Another limitation in the measurement of a small SWR is the requirement for an RF generator with a high level output and an oscilloscope with high vertical sensitivity in order to obtain a useful amplitude display. For instance, when measuring an SWR of 1.06 with an RF sweep generator output of 1V rms, the output of the bridge is typically only 600μV; thus an oscilloscope with a vertical sensitivity of at least 100μV per cm or greater is required in order to obtain a full scale display. However, if accessory equipment such as the WILTRON Model 501/501B is available (see Section V), SWR measurements can be made over RF power levels from -40 to +20 dBm because of the dc gain provided by the instrument.

2-4.2 ACCURACY LIMITATIONS WHEN MEASURING A LARGE SWR

For SWR measurements between 1.5 and 30, the major accuracy limitation of an autotester or bridge is the output SWR. This is the SWR that is presented to the device under test. The output mismatch causes a portion of the reflected signal from the device under test to be returned (re-reflected). This effect results in an error signal due to the many reflections. For example, using an SWR bridge with an output SWR of 1.2 (reflection coefficient of .09) to measure a device with an input SWR of 1.5 (reflection coefficient of .2) would produce a reflection coefficient error signal of 1.8%. This is calculated as follows.

% Error = $\rho_1\rho_2$ x 100, where ρ_1 is the reflection coefficient of the bridge output and ρ_2 is the reflection coefficient of the test device input.

In the above example the reflection coefficient error signal of 1.8% limits the practical SWR measuring range to approximately 30:1.

2-4.3 TYPE N PRECISION CONNECTORS

WILTRON SWR autotesters and bridges with a Type N connector at the test port have precision dimensions as shown in Figure 2-7. For accurate SWR measurements, especially above 2 GHz, it is recommended that the mating Type N connector have the same nominal dimensions.

2-4.4 RF LEVELING

If the RF sweep generator is not adequately leveled, the reference line on the oscilloscope display will not be flat over the swept frequency range. Also, at the extremes of the frequency range of an autotester or bridge, the reference line may slope because of the frequency response of the detector. The effect can be minimized by calibrating to the average value of the trace, or calibrating at the frequency region where greatest accuracy is required.

2-4.5 CALIBRATED MISMATCH

Calibrated mismatches, such as a GR Type 900 or a WR120, may be used as an alternative method of calibrating the SWR graticules (see paragraph 2-8).

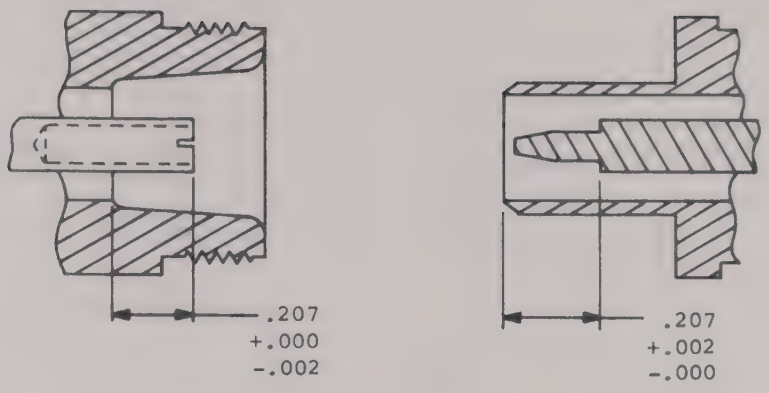


Figure 2-7. Precision Type N Connector Dimensions (inches)

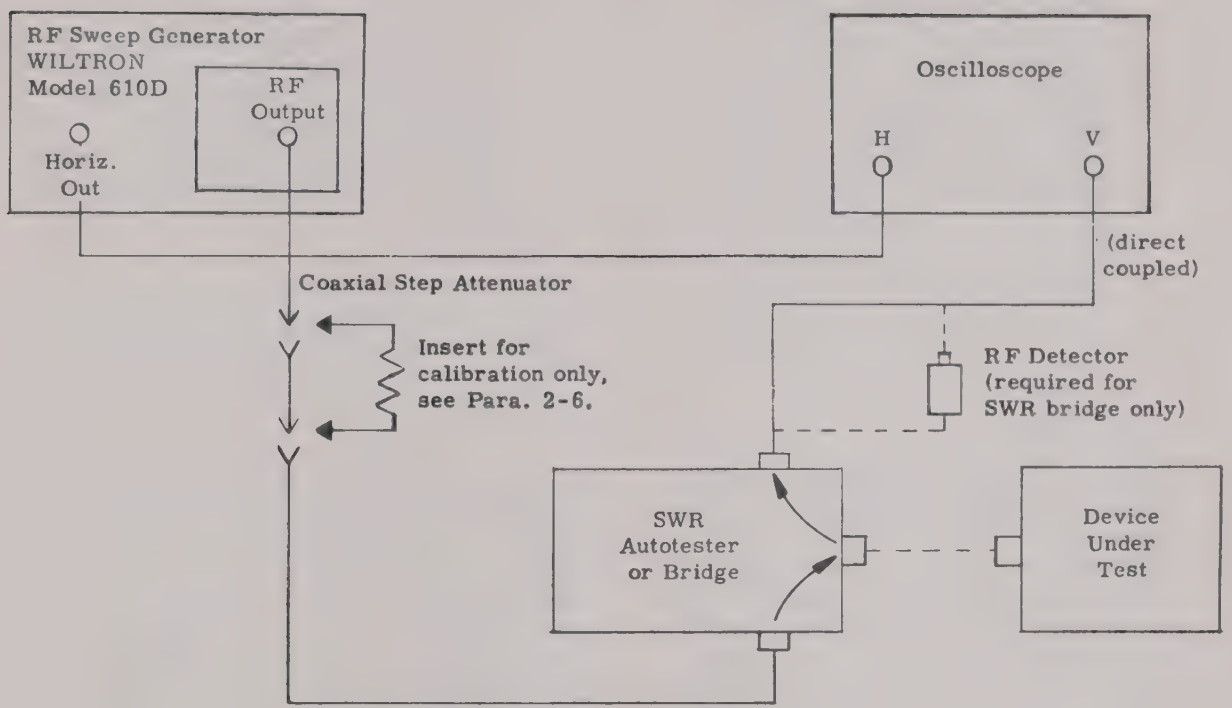
2-5 SWR AND RETURN LOSS MEASUREMENT PROCEDURES

Paragraphs 2-6 through 2-10 describe the various methods of making swept-frequency SWR and return loss measurements using an autotester or bridge. The basic test set-up is shown in Figure 2-8. When an SWR bridge is used, a suitable RF detector is connected between the bridge output and the oscilloscope. If the sweep generator plug-in is designed for external leveling, refer to the plug-in manual for additional connections required.

2-6 SWR MEASUREMENTS USING GRATICULES

This procedure describes how to make swept-frequency SWR measurements using the graticules supplied with the SWR autotester or bridge. Proceed as follows:

1. Adjust the RF sweep generator for minimum output level.
2. Connect the test equipment as shown in Figure 2-8 with the device under test disconnected from the test port. Use the direct coupled (dc) vertical input of the oscilloscope. Also ensure that coaxial cables of the correct impedance are used.
3. Select the graticule for 0 dB return loss (Figure 2-6).
4. Set the vertical sensitivity of the oscilloscope to 1mV per cm. Set the horizontal sensitivity to give 10 cm deflection.
5. Increase or decrease the RF sweep generator output as necessary to provide 6 cm vertical deflection (equal to 6mV signal level from the detector).



CAUTION

RF Input to autotester or bridge must be less than one-half watt.

Figure 2-8. SWR Measurement Test Setup.

NOTE

This trace is a calibrated value of a complete mismatch and an SWR that approaches infinity. The RF signal trace should be horizontal and superimposed on the ∞ (0 dB) line over the full swept frequency range. The blanking trace should be on the 1.0 line. The signal trace may not be uniform with frequency because of imperfections due to RF leveling, cable mismatch, etc. The trace should be calibrated for its average value to be correct, or optimized over a preferred frequency range.

6. Connect the device under test to the SWR autotester or bridge and observe the approximate SWR reading on the 0 dB return loss graticule. This will indicate which of the other graticules to select for the final measurement. For example, if the reading is between 1.0 and 2.0, select the 10 dB return loss graticule, Figure 2-5. If close to 1.0, select either the 20 dB or 30 dB graticule.

CAUTION

RF power input to the autotester or bridge must be less than one-half watt. Higher power levels will damage the internal bridge network.

7. Again disconnect the device under test from the autotester or bridge.

8. Insert a coaxial calibration attenuator, having a loss in dB equal to that on the bottom line of the graticule, between the RF sweep generator and the autotester or bridge.

9. Increase the vertical sensitivity of the oscilloscope and/or readjust the RF level to set the signal trace on the bottom line of the graticule. This calibrates the test setup for the particular graticule.

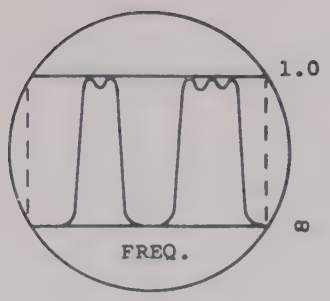
10. Remove the coaxial calibration attenuator and reconnect the device under test to the autotester or bridge. The signal trace on the oscilloscope is the readout of the SWR for the device under test over the swept frequency range.

Typical readout curves for various devices are shown in Figure 2-9. Any particular frequency or portion of the swept range can be examined by adjusting the RF sweep generator accordingly:

Once having made a calibration setup, different types of tests, measurements or adjustments of devices under test can be observed at a glance. Many tests require only adjusting for minimum SWR or assuring that the SWR is within a minimum value. In these cases, a signal calibration for the measurement consists of checking that the swept frequency plot (display) does not go below the reference line.

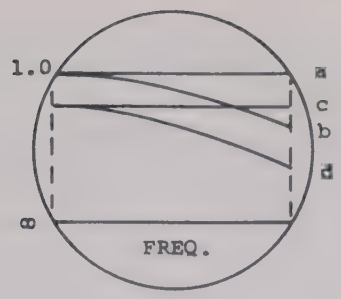
2-7 RETURN LOSS MEASUREMENT USING A KNOWN ATTENUATION

The following procedure is used to make swept frequency return loss measurements. This procedure does not require the graticules supplied with the SWR autotester or bridge. The measurement is made using a "loss substitution" technique, which introduces a known amount of attenuation into the test setup. The resulting return loss reading can easily be converted to SWR using the nomographs supplied at the end of the manual. Measure the return loss as follows:

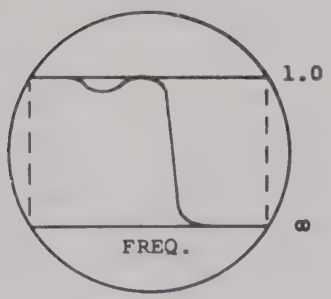


A Two Channel Aircraft Beacon and Communications Antenna

SWR

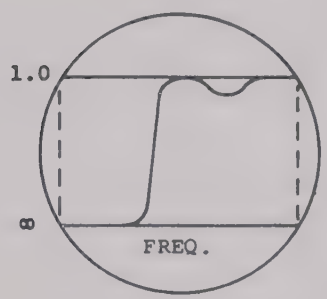


(a) 50 ohm Coax Termination
(b) 50 ohm Resistor
(c) 75 ohm Coax Termination
(d) 75 ohm Resistor

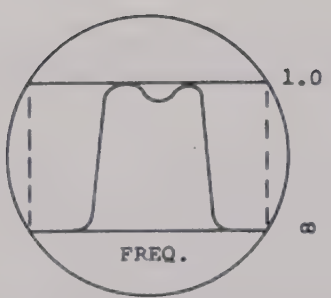


Low Pass Filter

SWR

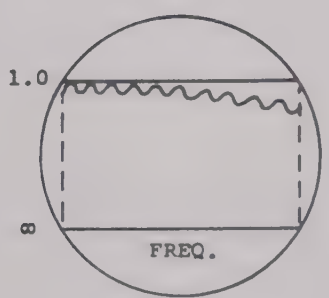


High Pass Filter



Band Pass Filter

SWR



Long Length of 50 ohm Coaxial Cable Terminated with 50 Ohms

Figure 2-9. Typical SWR Displays

1. Connect the test equipment as shown in Figure 2-8.

2. Attach the device to be tested at the test port of the autotester or bridge.

3. Adjust the oscilloscope vertical and horizontal sensitivity to display the sweep frequency plot. Mark the position of the plot using a grease pencil or other suitable method.

4. Disconnect the device under test from the test port.

5. Connect increasingly greater amounts of attenuation between the RF sweep generator and the autotester or bridge until the swept frequency line on the oscilloscope coincides with the level noted in step 3. The amount of attenuation introduced represents the return loss of the device under test.

2-8 RETURN LOSS MEASUREMENT USING A CALIBRATED MISMATCH

This procedure uses a calibrated mismatch to measure the return loss of the device under test. The calibrated mismatch serves as a known reference of return loss against which the device under test is measured. Perform the measurement as follows:

1. Connect the equipment as shown in Figure 2-8, with the device under test disconnected from the autotester or bridge test port.

2. Attach the selected calibrated mismatch to the test port of the autotester or bridge.

3. Adjust the oscilloscope vertical and horizontal sensitivity to display the swept frequency plot, as described in steps 4 and 5 of paragraph 2-6.

4. Mark the position of the plot using a grease pencil or other method.

5. Remove the calibrated mismatch from the autotester or bridge.

6. Connect the device to be tested to the autotester or bridge test port.

7. If the new swept frequency plot exceeds the reference line established in step 4, the return loss is less than that of the calibrated mismatch, and if it does not reach the reference line, the return loss is greater than the calibrated mismatch.

2-9 SWR MEASUREMENT AT LOW RF LEVELS

The following procedure is used when SWR measurements are made on low level devices such as preamplifiers, mixers, modulators, etc. For this type of measurement, an SWR bridge and external RF detector is preferred over an autotester because an RF amplifier can be used to amplify the low level RF signal prior to detection. This technique provides sufficient detector output to obtain an adequate oscilloscope display. To make the measurement, proceed as follows:

1. Connect the test equipment as shown in Figure 2-10, with the device under test disconnected.

2. Set the oscilloscope vertical sensitivity to 1 mV per cm and the horizontal sensitivity for 10 cm deflection.

3. Adjust the RF sweep generator output level to provide 6 cm deflection (equal to 6 mV signal level from the detector).

4. Connect the device under test to the autotester or bridge test port.

5. Using the 0 dB return loss graticule, note the SWR reading. Select the graticule with a range closest to the SWR reading. This will indicate which of the other graticules to select for the final measurement. For example, if

the reading is between 1.0 and 2.0, select the 10 dB return loss graticule.

6. Again disconnect the device under test from the autotester or bridge.

7. Insert a coaxial attenuator having a loss in dB equal to that on the bottom line of the graticule between the RF sweep generator and the autotester or bridge.

8. Increase the vertical sensitivity of the oscilloscope and/or increase the RF level to set the signal trace on the bottom line of the graticule. This calibrates the test setup for the particular graticule.

9. Remove the coaxial calibration attenuator and reconnect the device under test to the autotester or bridge. The signal trace on the oscilloscope is the readout of the device under test over the swept frequency range.

2-10 RETURN LOSS MEASUREMENTS USING A LOGARITHMIC LEVEL METER

A logarithmic level meter such as the WILTRON Model 501/501B can be used to obtain a return loss reading in dB over an RF power level range of -40 to +20 dBm, (to -80 dBm with Model 501B). The return loss is read on a linear scale for fixed-frequency measurements, or on an oscilloscope for swept-frequency measurements. Details of the Model 501/501B are provided in Section V of this manual. Refer to the Model 501/501B instruction manual for procedures for making return loss measurements with the logarithmic level meter.

2-11 RF MEASUREMENT CHART

The RF measurement chart, Table 2-1, can be used to convert from SWR to reflection coefficient and return loss using the first three columns. The chart is also useful for determining the interaction between any two phasors when the larger phasor is normalized to unity, by using the last four columns.

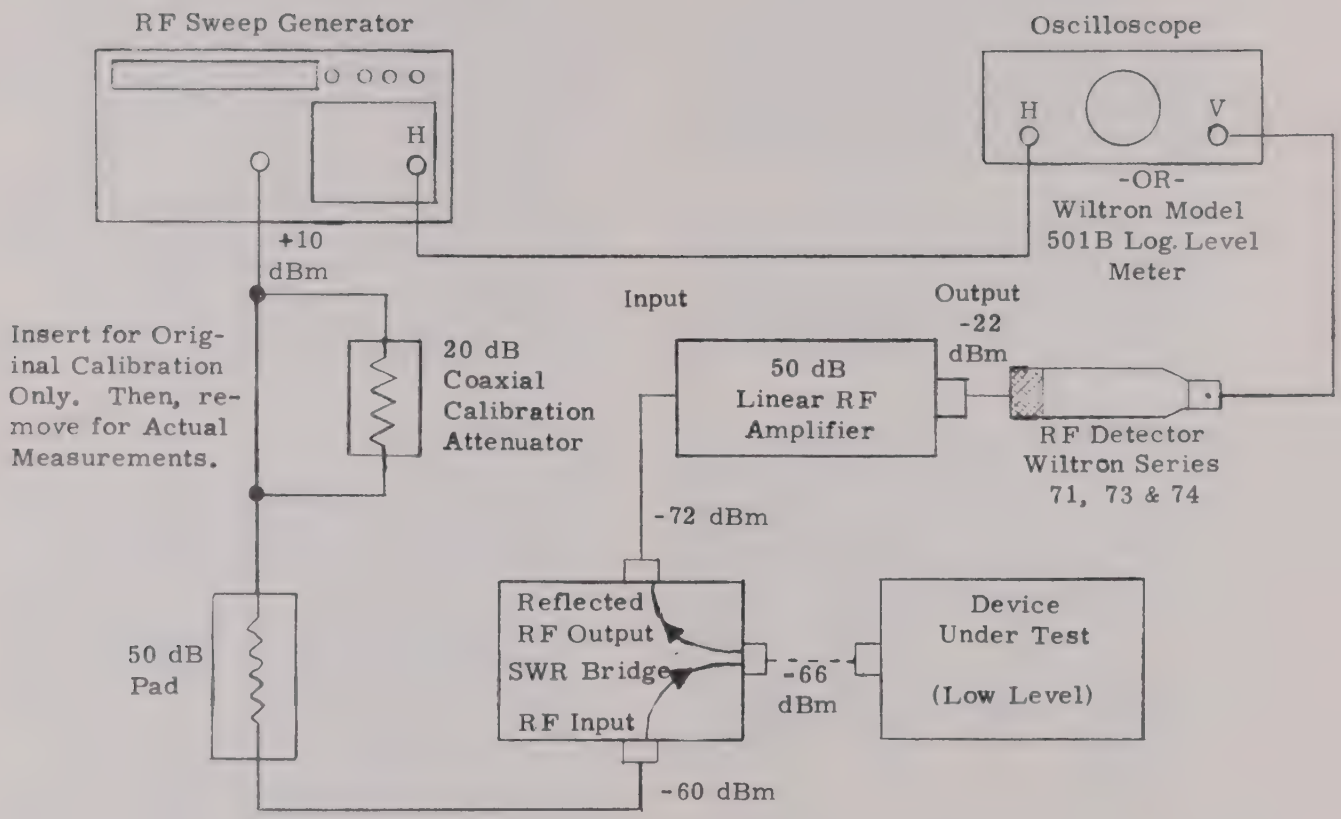
For SWR measurements, the chart can be used to find the error limits of a measurement due to the directivity and test port match of the SWR bridge. Examples of using the chart to calculate the error limits are given below.

Example A:

A device with a 20 dB return loss is measured using an SWR bridge have a directivity of 35 dB. The difference between the bridge directivity and the return loss value of the device is 15 dB. From Table 2-1, this gives error limits of 1.42 and 1.70 (read from the 1+X dB and 1-X dB columns). Since return loss is being measured, the reference is negative. Thus, the error limits are 20 dB minus 1.42, and 20 dB plus 1.70, or 18.58 to 21.70 dB. The actual measured value is somewhere within these limits.

Example B:

An SWR bridge has a test port match of 1.25 SWR. As converted from Table 2-1, this is 19 dB below a complete reflection, which is used for a reference. Reading from the 1+X dB and 1-X dB columns, it is seen that the error limits for the reference due to test port match are -0.92 dB and +1.03 dB.



NOTE

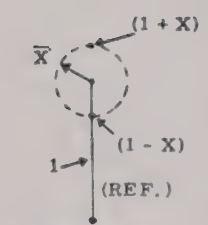
The dBm levels shown are typical for an SWR between 1.0 and 1.22.

Figure 2-10. SWR Measurement of a Low Level Device.

Table 2-1.
RF MEASUREMENT CHART

Conversion tables for Return Loss, Reflection Coefficient, and SWR with tabular values for interactions of a small phasor x with a large phasor (unity reference) expressed in dB related to reference.

			Relative to Unity Reference			
SWR	Reflection Coefficient	Return Loss dB	x dB Below Reference	1 + x dB	1 - x dB	1 ± x Peak to Peak Ripple dB
17.3910	.8913	1	1	5.5350	-19.2715	24.8065
8.7242	.7943	2	2	5.0780	-13.7365	18.8145
5.8480	.7079	3	3	4.6495	-10.6907	15.3402
4.4194	.6310	4	4	4.2489	-8.6585	12.9073
3.5698	.5623	5	5	3.8755	-7.1773	11.0528
3.0095	.5012	6	6	3.5287	-6.0412	9.5699
2.6146	.4467	7	7	3.2075	-5.1405	8.3480
2.3229	.3981	8	8	2.9108	-4.4096	7.3204
2.0999	.3548	9	9	2.6376	-3.8063	6.4439
1.9250	.3162	10	10	2.3866	-3.3018	5.6884
1.7849	.2818	11	11	2.1567	-2.8756	5.0322
1.6709	.2512	12	12	1.9465	-2.5126	4.4590
1.5769	.2239	13	13	1.7547	-2.2013	3.9561
1.4985	.1995	14	14	1.5802	-1.9331	3.5133
1.4326	.1778	15	15	1.4216	-1.7007	3.1224
1.3767	.1585	16	16	1.2778	-1.4988	2.7766
1.3290	.1413	17	17	1.1476	-1.3227	2.4703
1.2880	.1259	18	18	1.0299	-1.1687	2.1986
1.2528	.1122	19	19	.9237	-1.0337	1.9574
1.2222	.1000	20	20	.8279	-.9151	1.7430
1.1957	.0891	21	21	.7416	-.8108	1.5524
1.1726	.0794	22	22	.6639	-.7189	1.3828
1.1524	.0708	23	23	.5941	-.6378	1.2319
1.1347	.0631	24	24	.5314	-.5661	1.0975
1.1192	.0562	25	25	.4752	-.5027	.9779
1.1055	.0501	26	26	.4248	-.4466	.8714
1.0935	.0447	27	27	.3796	-.3969	.7765
1.0829	.0398	28	28	.3391	-.3529	.6919
1.0736	.0355	29	29	.3028	-.3138	.6166
1.0653	.0316	30	30	.2704	-.2791	.5495
1.0580	.0282	31	31	.2414	-.2483	.4897
1.0515	.0251	32	32	.2155	-.2210	.4365
1.0458	.0224	33	33	.1923	-.1967	.3890
1.0407	.0200	34	34	.1716	-.1751	.3467
1.0362	.0178	35	35	.1531	-.1558	.3090
1.0322	.0158	36	36	.1366	-.1388	.2753
1.0287	.0141	37	37	.1218	-.1236	.2454
1.0255	.0126	38	38	.1087	-.1100	.2187
1.0227	.0112	39	39	.0969	-.0980	.1949
1.0202	.0100	40	40	.0864	-.0873	.1737
1.0180	.0089	41	41	.0771	-.0778	.1548
1.0160	.0079	42	42	.0687	-.0693	.1380
1.0143	.0071	43	43	.0613	-.0617	.1230
1.0127	.0063	44	44	.0546	-.0550	.1096
1.0113	.0056	45	45	.0487	-.0490	.0977
1.0101	.0050	46	46	.0434	-.0436	.0871
1.0090	.0045	47	47	.0387	-.0389	.0776
1.0080	.0040	48	48	.0345	-.0346	.0692
1.0071	.0035	49	49	.0308	-.0309	.0616
1.0063	.0032	50	50	.0274	-.0275	.0549
1.0057	.0028	51	51	.0244	-.0245	.0490
1.0050	.0025	52	52	.0218	-.0218	.0436
1.0045	.0022	53	53	.0194	-.0195	.0389
1.0040	.0020	54	54	.0173	-.0173	.0347
1.0036	.0018	55	55	.0154	-.0155	.0309
1.0032	.0016	56	56	.0138	-.0138	.0275
1.0028	.0014	57	57	.0123	-.0123	.0245
1.0025	.0013	58	58	.0109	-.0109	.0219
1.0022	.0011	59	59	.0097	-.0098	.0195
1.0020	.0010	60	60	.0087	-.0087	.0174



PHASOR INTERACTION

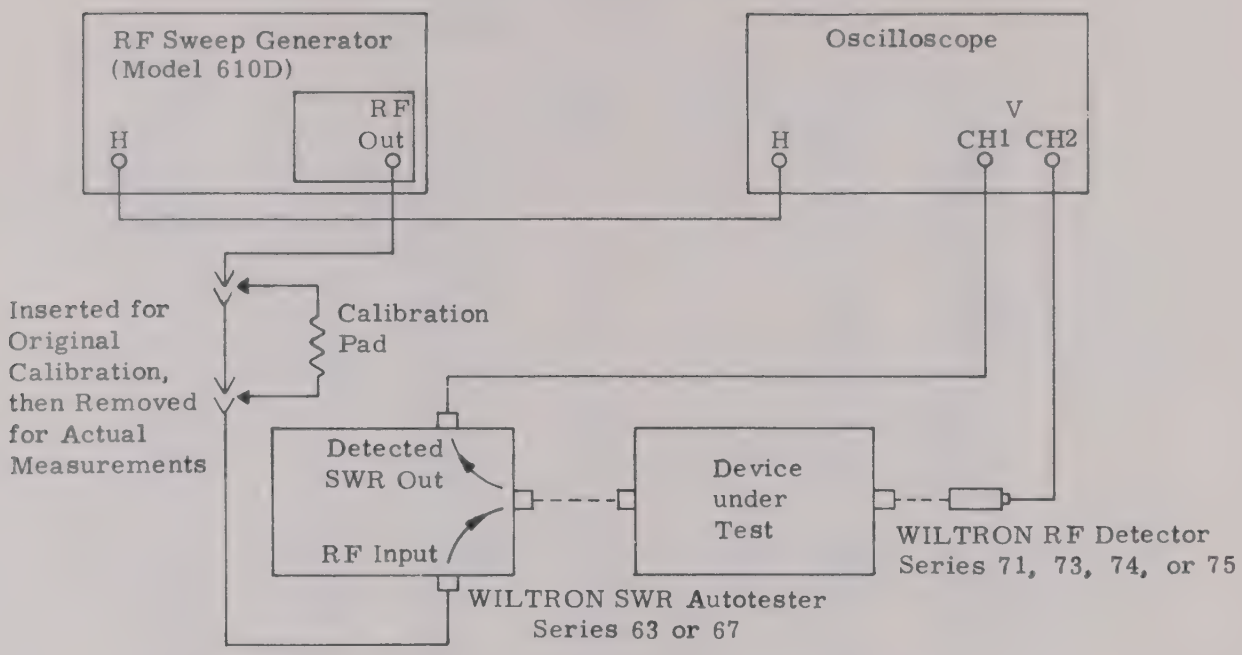


Figure 2-11. Simultaneous Swept Frequency Measurement of SWR and Transmission Loss Using a WILTRON SWR Autotester.

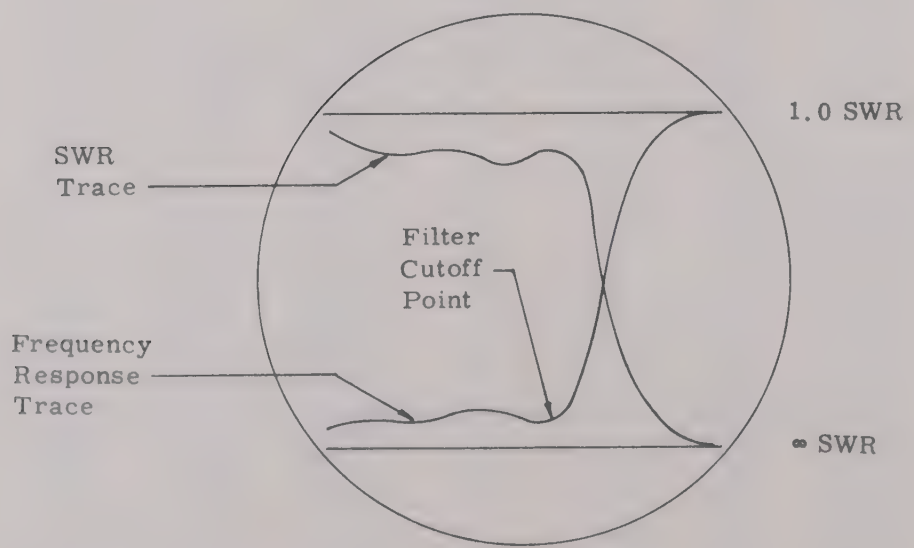


Figure 2-12. Simultaneous Swept-Frequency Measurement of SWR and Frequency Response for a Typical Low Pass Filter.

SECTION III
THEORY OF OPERATION

3-1 INTRODUCTION

This section of the manual describes how the SWR autotesters and bridges operate. The following discussion is only intended to acquaint the user with the measurement concept employed, and therefore does not include a mathematical analysis.

3-2 DESCRIPTION

A simplified diagram of a typical SWR bridge is shown in Figure 3-1. The autotester is identical to the bridge, except that the RF detector is housed within the device. The output of an RF generator is applied to the bridge circuit formed by resistances Ra, Rb, Rc, and Zx, the impedance of the device under test. Zdet is the input impedance of the RF detector and Zo is the output impedance of the RF generator. Resistances Ra, Rb, and Rc are precision resistors of a value equal to the specified bridge impedance (usually 50 or 75 ohms). When the impedance of the device under test, Zx is exactly equal to the bridge impedance, the RF detector input is zero volts. This occurs because equal voltages are present across Ra, Rb, Rc, and Zx. When the impedance of the device under test is either higher or lower than the bridge impedance, a voltage is applied to the RF detector that is proportional to the impedance ratio of Zx to Zbridge. Since SWR = $\frac{Zx}{Zbridge}$ or $\frac{Zbridge}{Zx}$, (whichever is greater) the detected RF output is proportional to the SWR of the device under test.

SWR is related to other transmission line measurements such as reflection coefficient, return loss in dB, etc. as shown in Nomographs 1, 2, and 3 at the end of this manual, and Table 2-1 in Section II.

The DC output voltage from the RF detector may be applied to a suitable test instrument such as an oscilloscope or network analyzer. If a sweep generator is used for the RF source, the oscilloscope displays the SWR of the device under test as a function of frequency. If the RF detector output is applied to a network analyzer (such as the WILTRON Model 310B/311) a Smith Chart display can be obtained.

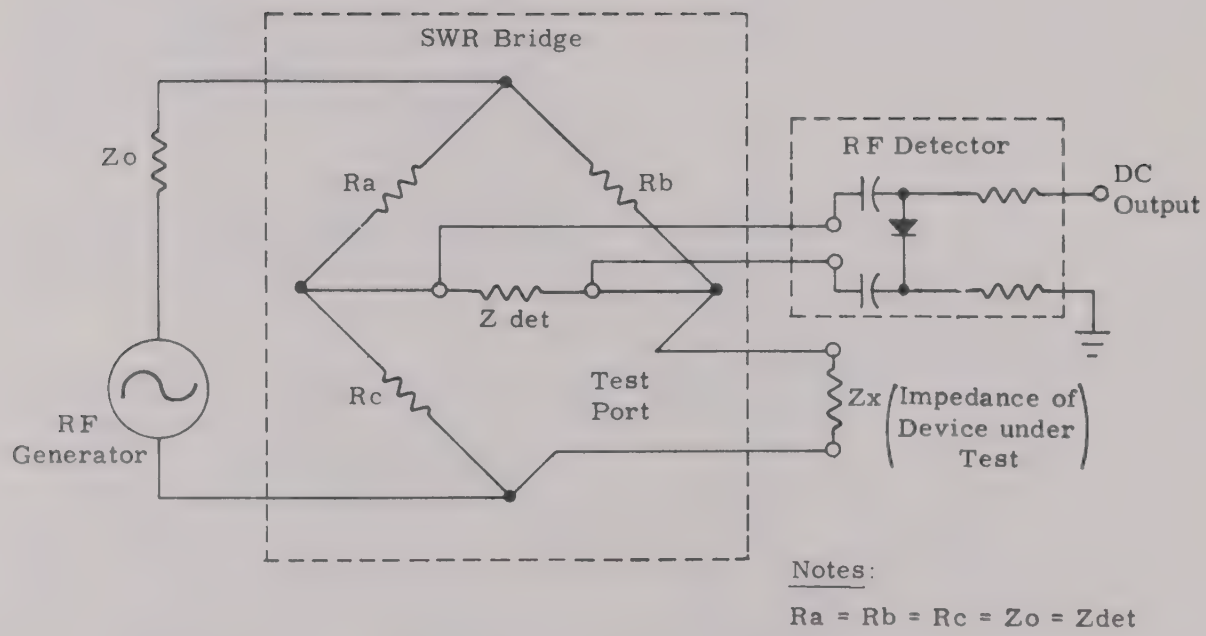


Figure 3-1. SWR Bridge, Simplified Schematic Diagram.

PERFORMANCE CHECKS

MAINTENANCE

SECTION IV

PERFORMANCE CHECK AND MAINTENANCE

4-1 INTRODUCTION

This section contains information for checking the performance of an SWR bridge or autotester. The performance check is made using a known calibrated mismatch (also called a reference offset), and only provides an approximate indication of the bridge or autotester directivity. For an accurate directivity measurement, or for calibration, the bridge or autotester must be tested using highly accurate equipment such as a precision air line. The bridge or autotester should be returned to the factory for maintenance if the appropriate test equipment is not available.

4-2 DIRECTIVITY CHECK (BALANCE OF BRIDGE OR AUTOTESTER)

Check the directivity of the SWR bridge or autotester as follows:

1. Connect the test equipment as shown in Figure 2-8, using a known calibrated mismatch in place of the device under test.

2. Measure the SWR as described in paragraph 2-6.

NOTE

There is approximately a 12.5 dB loss between the input and output of the bridge or autotester (approximately 6.5 dB from input to test port, and 6 dB from test port to output).

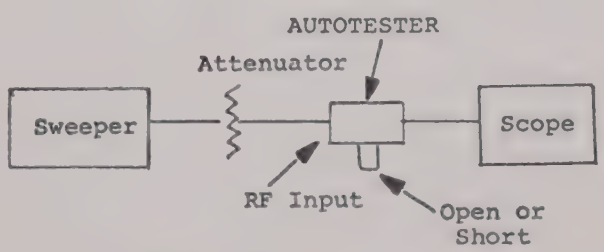
3. Compare the SWR reading obtained with that of the calibrated mismatch, taking into consideration the tolerance of the mismatch, the accuracy of the bridge or autotester being checked, and the accuracy of any adaptors used at the test port.

4. If the bridge or autotester is not within specifications as calculated in step 3, the device should be returned to the factory for maintenance.

4-3 AUTOTESTER OUTPUT CHECK

Use the following test setup to check if the detected output of the Model 63 or 67 Series Autotester is normal. The typical output for an RF input with a full reflection (measured at 100 MHz with a 1 megohm video load) is as follows:

RF INPUT	MODEL 63	MODEL 67
+10 dBm	135mV	125mV
0 dBm	25mV	20mV
-10 dBm	3.0mV	2.0mV
-20 dBm	0.3mV	0.2mV



4-4 MAINTENANCE

Customer maintenance of the SWR autotester or bridge is not recommended. Contact your local WILTRON engineering representative for factory service.

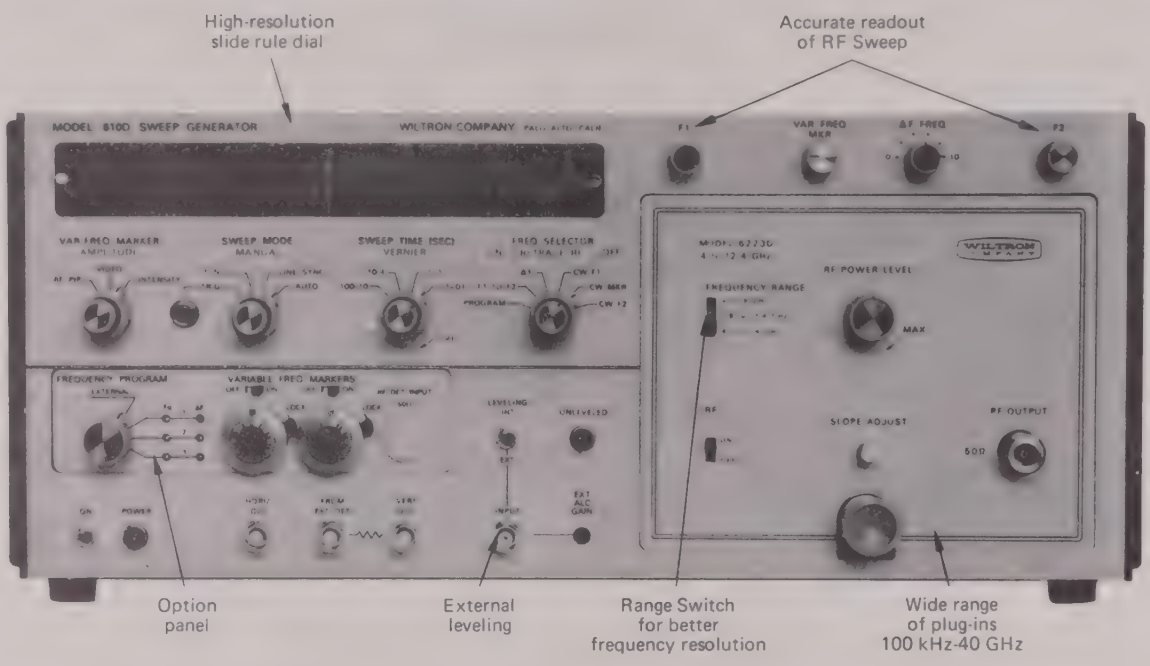
SECTION V
ACCESSORIES

5-1 GENERAL

This section describes accessory equipment that can be used with the SWR autotesters or bridges. A general description including specifications is provided for each accessory. For additional information, contact your local WILTRON representative.

All Solid State Sweep Generators
100 kHz to 40 GHz

MODEL 610D MAIN FRAME


High-resolution slide rule dial
Accurate readout of RF Sweep
Option panel
External leveling
Range Switch for better frequency resolution
Wide range of plug-ins 100 kHz-40 GHz

IMPORTANT FEATURES OF THE 610D INCLUDE:

COMPLETE, VERSATILE MARKER SYSTEMS

A selectable Intensity, Video or RF marker is standard with additional markers optionally available. The optional Harmonic and Fixed Frequency Markers allow precise determination of frequency to virtually 0.01%. In addition, an External RF Marker input is optional.

WILTRON offers the only sweeper with an Intensity Marking system which can be used with any oscilloscope and does not require Z-axis modulation of the scope. The WILTRON patented intensity dot is especially useful for indicators where attenuation or AGC is present. Since the dot is generated by merely stopping the sweep briefly and allowing the CRT brightness to build up, it operates independently of all external devices.

A SOPHISTICATED DISPLAY INTERFACE WHICH GUARANTEES A USEABLE, FLICKER-FREE DISPLAY

The 610D provides both positive and negative bandswitch blanking to eliminate bright intensity dots at the bandswitch points in multiband plug-ins. Another important feature is that all WILTRON plug-ins, including the extremely wideband 2 to 18.5 GHz and 10MHz to 18.5 GHz models, sweep fast enough to produce a flicker-free display when used with normal CRT phosphors.

COMPLETE COMPATIBILITY WITH -hp- NETWORK ANALYZERS

A standard feature of the 610D is complete compatibility with all -hp- 8410 network analyzers. Sequential sync, sweep dwell, and 1 volt/GHz signals are available on the 610D rear panel. Note that the 610D equipped with a Model 6247D plug-in furnishes continuous coverage over the entire 100 MHz to 18 GHz range of the 8410B.

BROADBAND PHASE LOCK AND FM CAPABILITY

The 610D may be used with an external phase lock synchronizer to obtain an extremely stable, low noise signal. WILTRON plug-ins use YIG-tuned oscillators, which may be phase-locked or frequency-modulated when equipped with Option 28. Frequency response of Option 28 is DC to 1 MHz.

EXTERNAL REMOTE PROGRAMMING

To facilitate control of output frequency, the 610D has been designed to be frequency programmable. The internal oscillators are voltage tunable, therefore an external voltage may be applied to the remote control terminal on the rear panel to obtain a desired CW output. An AC voltage superimposed on a DC level will provide a sweep type output. Sensitivity of the 610D is 9.75 volts for a full-band frequency change. The 610D itself also provides a full-band DC signal at the rear panel which may be used for programming.

ALSO AVAILABLE:

BCD Programming: See Option 15. IEEE Standard 488 Programming: See Option 16.

Model 610D Option Panel Allows You to Tailor the 610D Sweeper to Your Needs

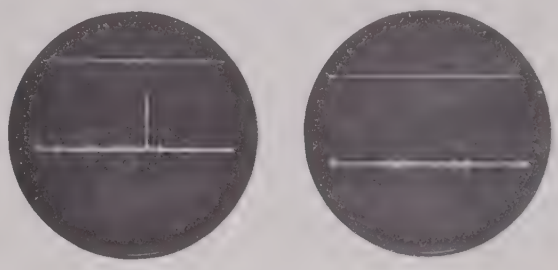
The 610D sweeper front panel contains a unique option panel which may be ordered with various options to tailor the sweeper to your specific measurement needs. A maximum of three of these front panel options may be ordered in each 610D, except that Options 1, 4 and 11 are not available in the same instrument.

USE WILTRON CRYSTAL MARKERS FOR SWEEP-FREQUENCY TESTING

HARMONIC MARKER COMB: OPTION 1

The WILTRON 610D is the only quality microwave sweeper available with harmonic marker combs. These optional crystal marker combs are especially convenient in determining the frequency of points of interest in sweep frequency displays. The 610D marker system is a precise but inexpensive system that provides a comb of harmonics of 1, 10, 50 or 100 MHz, accurate within 0.01%. The 1 MHz markers are usable to at least 3 GHz with the 10, 50 and 100 MHz markers usable to at least 8 GHz.

An important advantage of the WILTRON 610D marker system is that the harmonics are provided as a video output signal rather than being provided on the RF output signal. This allows the markers to be viewed on an oscilloscope display, but they are not a possible source of disturbance to the circuit being swept.



TYPICAL MARKER PRESENTATION
with Variable Marker Pip
and 50 MHz markers

EXPANDED SWEEP
1.05 to 1.053 GHz
with 1 MHz markers

Options 1, 4, and 2C shown

Options 4 and 11 shown

RF DETECTOR-50Ω or 75Ω, BNC or TYPE N: OPTION 2

The detector is available in four sub-options A, B, C, or D, to give you a choice of: A – a 50-ohm detector input using a type BNC connector, B – a 75-ohm input with type BNC connector, C – a 50-ohm input with type N connector, or D – a 75-ohm input with type N connector.

The option 2 detector is usable to 3 GHz (50-ohms) or 2 GHz (75-ohms).

PRESET FREQUENCIES: OPTION 4

Here is an option that can greatly assist you if your work involves repetitive testing at a few particular frequencies. With this option you have a panel switch that enables you to select any one of three preset bands. This is particularly useful with the Model 6247D wideband plug-in with which you can preset three complete frequency bands such as C, X, and Ku.

VARIABLE FREQUENCY MARKERS: OPTION 11

Option 11 provides two additional Variable Frequency Markers, which are available in both the ΔF and F1-F2 sweep modes. This makes these markers useful in both narrow band and broadband test applications.

BCD PROGRAMMING: OPTION 15

This option provides digital frequency control with 10,000-point resolution over the entire RF Plug-In frequency range, or the sweep range set by the front panel controls. Also, any of four internally-adjustable frequency ranges can be programmed.

GENERAL PURPOSE INTERFACE BUS: OPTION 16

Option 16 conforms to IEEE Standard 488-1975. This option provides digital frequency control with 10,000-point resolution over the complete RF Plug-In frequency range or any range set by the front panel controls. In addition, any of four internally-adjustable sweep ranges can be programmed with 10,000-point resolution. Other features provided with Option 16 include a programmable remote sweep triggering capability, and a programmable residual FM quieting filter

Model 610D Sweep Generator
Main Frame Specifications

FREQUENCY RANGE: 100 kHz to 40 GHz (determined by plug-in).

FREQUENCY DIAL: 7.3 inch (18.5 cm.) linear scale; machine divided.

SWEEP CONTROLS:

Start-Stop: Sweep from F1 to F2. Both F1 and F2 are independently adjustable over full range.

ΔF Sweep: Sweeps centered at Variable Frequency Marker setting. Width is adjustable 0 to 10% of the band. Control reads directly in % of the band calibrated up to 10% with ±10% accuracy.

CW Operation: Single-frequency output may be switch-selected at either F1, F2 or Variable Marker settings.

Remote: Permits sweeping with external voltage or programming sweep ΔF and center frequency with external resistors or voltages. See Option 4.

MARKER OUTPUTS:

Variable Frequency Markers: Three types of variable marker outputs available with 1% of-the-band accuracy.

RF Pip: Reduces RF momentarily; amplitude adjustable.

Video Marker: Adds negative video pulse to vertical output to oscilloscope.

Intensity Marker: Develops brightened dot on oscilloscope trace by momentarily slowing sweep.

SWEEP TIME: Continuously adjustable in four decade ranges 0.01 to 100 seconds per sweep.

SWEEP MODE:

Auto: Sweep occurs automatically.

Line Sync: Sweep occurs automatically synchronized with power line.

Manual: Front panel control provides continuous manual adjustment of frequency between the end frequencies set. The horizontal voltage out tracks this manual frequency.

Triggered: Single sweep is actuated by front panel pushbutton or external (>1 μs, +1 to +25 V) signal applied at rear.

RF RETRACE: The RF may be switched ON or OFF during the retrace period.

LEVELING: External leveling may be achieved with a negative detector. In addition, internal leveling is standard on most plug-ins.

HORIZONTAL OUTPUT: Direct coupled sawtooth 0 to +11.2 V concurrent with the sweep.

BLANKING OUTPUTS:

Retrace Blanking: Provides selectable + or -6V during retrace.

Bandswitch Blanking: Provides selectable + or -10V during Bandswitching.

1V/GHz OUTPUT: Provides a reference voltage proportional to the output frequency.

TRIGGER INPUT: Permits external triggering of sweep with a pulse >1 μs, +1V to +25V.

DWELL INPUT: Slows the sweep when a ground potential is applied.

MODULATION:

Internal AM: Square wave modulation of 1 kHz, adjustable in frequency, with an ON/OFF ratio of greater than 30 dB at rated output power.

External AM: 60 kHz bandwidth typical. Input impedance approximately 18k ohms, ac coupled.

EXTERNAL FM:

For Model 610D with any WILTRON Plug-In except Models 6104C and 61084D:

Sensitivity: ±1% of full band sweep per volt input.
Maximum input: ±10V peak.

With Option 28 Phase Lock* (fast FM):

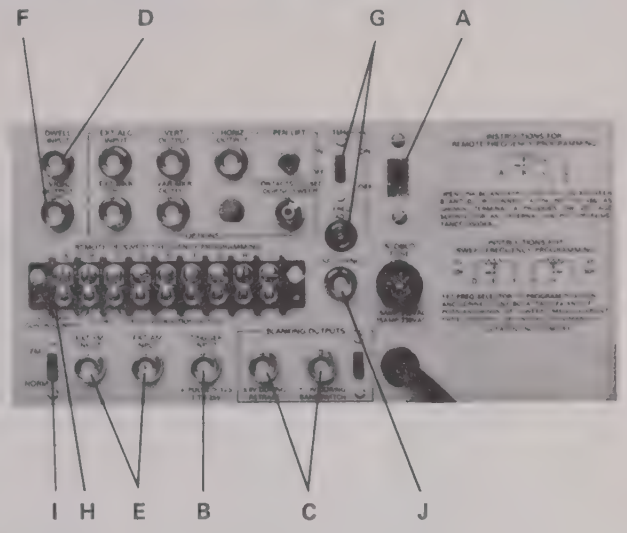
Sensitivity: 20 MHz/V or 6 MHz/V, switch-selectable.
Maximum input: ±10V peak.

*Option 28 enables the sweep generator to be phase-locked to a precise reference frequency, and permits frequency-modulation with a deviation as high as ±50 MHz (see table).

Deviation:

Modulation Frequency	Freq. Range	Deviation	
		Standard	With Option 28
DC to 100 Hz	Full band sweep	10%	N/A
100 Hz to 1 kHz	Full band sweep	1%	N/A
DC to 100 kHz	Below 8 GHz Above 8 GHz	N/A	±50 MHz ±35 MHz
100 kHz to 1 MHz	Below 8 GHz Above 8 GHz	N/A	±2 MHz ±2 MHz

REAR PANEL CONFIGURATION:



A 115/230V line selector switch (50 to 400 Hz)
B TRIGGER INPUT
C BLANKING and BANDSWITCH BLANKING OUTPUTS
D DWELL INPUT
E EXT AM and FM INPUTS
F 1V/GHz OUTPUT
G INTERNAL AM switch and FREQUENCY ADJUST
H REMOTE FREQUENCY PROGRAMMING terminals
I FM/NORMAL switch
J SEQUENTIAL SYNC OUTPUT

LINE POWER: 115/230 VAC, 50 to 400 Hz. 140 watts max.

WEIGHT: Model 610D Main Frame 18 pounds (8.2 kg.). Shipping Weight 26 pounds (11.8 kg.). Plug-In 10 pounds (4.5 kg.). Shipping Weight 14 pounds (typical) (6.4 kg.).

DIMENSIONS: 7" H x 17-9/16" W x 13-5/8" D. (17.8 cm. H x 44.6 cm. W x 34.6 cm. D).

OPTIONAL FEATURES: (Up to three can be provided on the front panel option panel except that Options 1, 4, and 11 are not available in the same instrument.)

1. CRYSTAL-CONTROLLED FREQUENCY MARKER COMBS: 1, 10, 50, and 100 MHz marker spacing
2A RF DETECTOR: 50 ohms; BNC female
2B RF DETECTOR: 75 ohms; BNC female
2C RF DETECTOR: 50 ohms; Type N female
2D RF DETECTOR: 75 ohms; Type N female
4. PRESET FREQUENCIES: enables setting up to 3 output center frequencies and sweep widths on front option panel
11. TWO ADDITIONAL VARIABLE FREQUENCY MARKERS

OPTIONAL FEATURES: (Terminals at the rear)

5. VERTICAL OUTPUT in parallel with front panel connector
6. HORIZONTAL OUTPUT in parallel with front panel connector
7. EXT LEVELING INPUT in parallel with front panel connector
8. VARIABLE MARKER OUT pulse coincident with variable frequency marker
9. PEN LIFT CONTACTS; contact closure during sweep
14. EXTERNAL RF MARKER INPUT accepts 1MHz to 1000 MHz signal to produce a frequency marker.
15. BCD Programming
16. General Purpose Interface Bus

P/N 2000-55 Interface Cable, 2 meters long, for use with Opt. 16

OPTIONAL ACCESSORIES: Plug-in extender cable
Extender card for 610D PC boards

RF Plug-Ins for Model 610

Multiband Sweep Generator Plug-ins

Model	Frequency Range GHz	Max Level Output mW(dBm)	Max Level Variation Int. Level (dB)
6221D	2.0-12.4	5 mW (+7 dBm)	±0.6
"	"	Option 10: 10 mw (+10 dBm)	"
6225D	4.0-18.5	5 mW (+7 dBm)	±0.9
"	"	Option 10: 10 mw (+10 dBm)	"
6237D	2.0-18.5	5 mW (+7 dBm)	±0.9
"	"	Option 10: 10 mw (+10 dBm)	"
6247D	0.01-18.5	5 mW (+7 dBm)	±1.0
"	"	Option 10: 10 mw (+10 dBm)	"

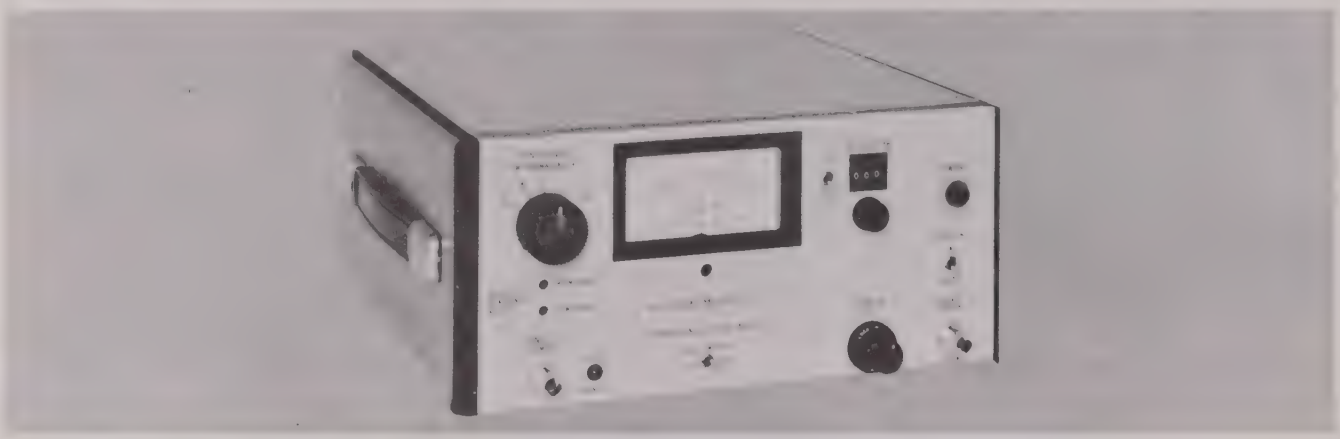
Dual Band Sweep Generator Plug-ins

6211D	0.5-2.0	10 mW (+10 dBm)	±0.3
6213D	0.01-4.2	8 mW (+ 9 dBm)	±0.4
6215D	1.0-4.0	20 mW (+13 dBm)	±0.3
6219D	2.0-8.0	10 mW (+10 dBm)	±0.4
6223D	4.0-12.4	10 mW (+10 dBm)	±0.5
6229D	7.9-18.5	8 mW (+ 9 dBm)	±0.8

Single Band Sweep Generator Plug-ins

Model	Frequency Range (MHz)	Max Level Output mW/(dBm)	Max Level Variation Int. Level (dB)	Built-in Attenuator Calibrated in 1 dB Steps (dB)
6104C	0.1-110	20 mW (+13 dBm)	±0.15	79
61084D	1-1,500	10 mW (+10 dBm)	±0.2	79
6110D	1,000-2,000	20 mW (+13 dBm)	±0.3	–
6112D	1,400-2,500	20 mW (+13 dBm)	±0.2	–
6114D	2,000-4,000	20 mW (+13 dBm)	±0.3	–
6116D	1,700-4,300	10 mW (+10 dBm)	±0.4	–
6120D	3,600-6,500	10 mW (+10 dBm)	±0.25(±0.03/30MHz)	–
6124D	4,000-8,000	10 mW (+10 dBm)	±0.4	–
6126D	3,700-8,300	10 mW (+10 dBm)	±0.5	–
6127D	5,900-9,000	10 mW (+10 dBm)	±0.3	–
6128D	7,900-12,400	10 mW (+10 dBm)	±0.4	–
6130D	12,400-18,500	10 mW (+10 dBm)	±0.5	–
6131D	10,000-15,500	10 mW (+10 dBm)	±0.4	–
6132D	17,000-22,000	5 mW (+ 7 dBm)	±0.5	–
6136D-1	18,000-26,500	3 mW (+ 5 dBm)	–	–
6140D-1	26,500-40,000	2 mW (+ 3 dBm)	–	–

Logarithmic Level Meter



- **Accurate low level RF measurements to −40 dBm**
- **Direct meter readout on a linear dB scale**
- **Calibrated offset**
- **60 dB of total dynamic range**

The WILTRON Model 501 Logarithmic Level Meter converts the DC voltage from an external crystal detector to an indication of RF power calibrated in dB per division. Two simple front panel adjustments permit calibration of a wide range of crystal detectors for operation from −40 dBm to +20 dBm. This results in an entire 60 dB dynamic measurement range. In addition, a calibrated offset control provides more than ±90 dB offset range

A meter readout is provided for CW measurements or the simple addition of an oscilloscope with 1 volt per division sensitivity allows swept frequency measurements. Sensitivities of 10, 5, 2, 1 and 0.5 dB/div are available at the flick of the Panel Range Switch

The Level Meter is an ideal accessory for use with WILTRON's complete line of SWR bridges and autotesters.

SPECIFICATIONS

FREQUENCY RANGE: Limited only by the RF detector and connectors used. (The WILTRON 75N50 is ideal for wideband measurements to 18.5 GHz)

FLATNESS: Determined by the RF detector

DYNAMIC RANGE: −40 to +20 dBm applied to external RF detector.

ACCURACY: ±0.3 dB ±1% of dB readout with all WILTRON detectors.

OFFSET: Calibrated over more than ±90 dB range.

DISPLAY SENSITIVITIES: 10, 5, 2, 1 or 0.5 dB per major meter division

VIDEO OUTPUT: 5K ohms or less source impedance When using an oscilloscope with 1 volt per division vertical sensitivity, the display becomes 10, 5, 2, 1 or 0.5 dB per division.

PHYSICAL DESCRIPTION: Dimensions: 12" wide x 5¼" high x 12" deep. Net weight 8 lbs

WILTRON 501B Logarithmic Meter

For SWR Measurements of very small reflected RF signals (down to −80 dBm) the WILTRON Model 501B includes all the video features of the 501, and in addition has a built-in 40 dB RF amplifier and detector operating from 5 MHz to 1000 MHz.

- **Direct low level RF measurements, 5 to 1000 MHz**
- **−80 dBm minimum level**
- **100 dB total dynamic range**
- **Flatness (with int. detector):**

	With Amp.	Without Amp.
501B 50Ω	±1.8 dB to 1000 MHz	±0.3 dB to 2000 MHz
501B 75Ω	±2 dB to 1000 MHz	±0.8 dB to 1000 MHz

SPECIFICATIONS

FREQUENCY RANGE: With internal RF amplification: 5 1000 MHz. With external detector: limited only by detector

SENSITIVITY: +20 to −80 dBm (internal RF amplification) +20 to −40 dBm (without RF amplification)

dB ACCURACY: ±0.3 dB±1% of dB readout (without RF amplification). With internal RF amplification add compression of approximately −0.3 dB at −70 dBm and −1 dB at −80 dBm.

DISPLAYED SENSITIVITIES: 10, 5, 2, 1 or 0.5 dB per meter division

DC OUTPUT: 5K ohms or less source impedance delivering 1v/div for Displayed Sensitivities

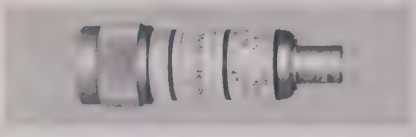
PHYSICAL DESCRIPTION: Dimensions: 17" wide x 5¼" high x 12" deep. Net weight 12 lbs.

RF Detectors and RF Sampling Directional Detectors

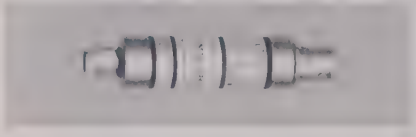
WILTRON offers the industry's most extensive line of R.F. detectors; models are included for general purpose applications with a variety of connectors, impedances, frequency ranges and prices. All units are offered with either negative or positive output voltage. (Negative is the more conventional.)

71 SERIES – WILTRON's popular general purpose detector offers unique low frequency performance down to 100 kHz and up to 3 GHz with characteristic input impedance of either 50 or 75 ohms and with positive ***or*** negative output voltage. The Model 71B50 is the most popular detector in this series.

73 SERIES – General Purpose, good high frequency coverage to 4 GHz. Type N input connector. Low SWR is typically 1.1.



74 SERIES – High quality and wide bandwidth detector. Has matched input and shaped polyiron for careful frequency compensation. Better low frequency performance than competing manufacturers. The Model 74N50 is the most popular model in this series.



75 SERIES – WILTRON extended bandwidth detector covers from 10 MHz to 18.5 GHz with exceptional flatness of ±0.5 dB to 12.4 GHz and ±1 dB to 18.5 GHz. Choice of Type N, APC-7, or SMA input connector.

710 SERIES – Low-cost directional detector for externally leveling sweepers from 1 MHz to 2 GHz. Flat within ±0.2 dB, 10 to 1220 MHz; within ±0.4 dB, 1 to 2000 MHz. Maximum insertion loss, 2 dB; directivity greater than 20 dB; coupling factor, 14 dB; 50-ohm Type N connectors. Maximum SWR, 1.4. One watt max; 100 pF output capacitance and negative output polarity.

MODEL SPECIFICATIONS

All Models (except Model 710) have a field-replaceable diode

Series 71 and 73 RF detectors use a zero-bias Schottky barrier diode.

All WILTRON RF detectors are compatible with the Model 501 Log. Level Meter.

MODEL	DESCRIPTION	FREQ RANGE	FLATNESS	CONNECTOR IN	CONNECTOR OUT	IMPEDANCE	MAX. SWR	LOW LEVEL SENSITIVITY AT –30 dBm	HIGH LEVEL SENSITIVITY AT +13 dBm	FIELD REPLACEABLE DIODE	MAX. INPUT	OUTPUT CAPACITANCE	OUTPUT VOLTAGE POLARITY	
71 [illegible]	Gen. Purpose (BNC Input)	100 kHz to 3 GHz	±0.5 dB	BNC Male	BNC Female	50 ohms	1.20	0.35mv/μW	1V min	Yes	100mw	500pF	Neg	
71 [illegible]P													Pos	
71 [illegible]5		100 kHz to 2GHz				75 ohms	1.25				60mw		Neg	
71 [illegible]P													Pos	
73 N50	Gen. Purpose Type N Input	100 kHz to 4 GHz	±0.5 dB	N Male	BNC Female	50 ohms	1.20	0.35mv μW	1V min	Yes	100mw	500pF	Neg	
73 [illegible]P													Pos	
74 [illegible]50	Wide Band Gen. Purpose	10 MHz to 12.4 GHz	±0.2 dB 10MHz–8GHz ±0.5 overall	N Male	BNC Female	50 ohms	1.20 to 4.5GHz 1.35 to 7.0GHz 1.50 to 12.4GHz	0.4mv/μW	1V min	Yes	100mw	30pF	Neg	
74 [illegible]P													Pos	
74 [illegible]				SMA Male									Neg	
74 [illegible]P													Pos	
75 [illegible]	Extended [illegible]	[illegible]	[illegible]	APC-7	BNC Female	50 ohms	1.2 to 4 [illegible] 1.35 to [illegible] 1.7 to 18 GHz			Yes		20pF	Neg Pos	
75 [illegible]				N Male									Neg Pos	
75 [illegible]				SMA Male									Neg Pos	
710	[illegible]	[illegible]	[illegible]	N Female	N Male	[illegible]	1.40	—	—	No	1 Watt	1000pF	Neg	

Highest Precision Swept SWR Measurement System

MEASUREMENT METHODS

There are three methods of conducting measurements, depending upon the precision required. In each method the accuracy will be slightly reduced when precision adapters are used.

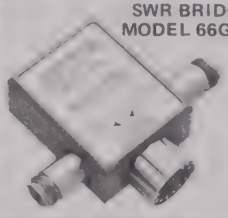
1. Direct Measurement Method: This method provides direct-reading measurements to 40 dB for checking conventional terminations, couplers, and bridges. Virtually any type of device-under-test can be accommodated.
2. Error Averaging Method: This method provides improved measurements to 54 dB, and is suitable for checking devices that are uniform in their characteristics over wide frequency ratios, such as reference terminations and precision bridges.
3. Magnified Measurement Method: This method is similar

50 ohm SWR Bridges & References

66G50 SERIES — PRECISION SWR BRIDGE Measures SWR to 1.002 (with internal 50 ohm reference terminations)

Model	Freq. Range (MHz)	Directivity (dB)	Connector	*Accuracy	
				.0025 ± 0.10ρ^2	

*Where ρ is the reflection coefficient being measured.



SWR BRIDGE MODEL 66G50L

INPUT/OUTPUT CONNECTORS: Type N Female, Stainless Steel
INSERTION LOSS: 6.5 dB nominal (from input to test port)
MAXIMUM POWER INPUT: 1/2 W
WEIGHT: 16.5 Ounces
DIMENSIONS: 4" x 2-3/8" x 1-1/2"

58A50 BROADBAND SWR BRIDGE (FOUR PORT)

For use with external reference termination)

Model	Freq. Range (GHz)	Directivity (dB)	Connector	*Accuracy	
58A50	2.0-18	35	APC-7	.018 ±0.20ρ^2 2 to 4.0 GHz	

*When used with reference termination. Accuracy even greater when used with 18A50 air line and 29A50-20 offset in the magnified measurement method.

RECOMMENDED ACCESSORIES:
MODEL 28 SERIES TERMINATIONS AND MODEL 75 SERIES RF DETECTORS

INPUT/OUTPUT CONNECTORS: Type N Female, Stainless Steel
INSERTION LOSS: 6.5 dB nominal (from input to test port)
MAXIMUM POWER INPUT: 1/2 W
WEIGHT: 12 Ounces
DIMENSIONS: 2-5/8" x 2" x 7/8"

TERMINATIONS

Model	Freq. Range (GHz)	Connector	SWR (F in GHz)	
			1.002 + 0.002F	
			1.002 + 0.003F	
			1.002 + 0.003F	
			1.004 + 0.004F	
			1.004 + 0.004F	
			1.01 + 0.001F	
			1.01 + 0.001F DC to 10 GHz	
			1.02 10 to 18 GHz	

*Using 26G50 termination with 32GB50 or 32GBF50 adapter.

TERMINATION MODEL 28A50-1

TERMINATION MODEL 26G50

TERMINATIONS PROVIDE:
- **ACCURATE REFERENCE FOR SWR MEASUREMENT**
- **TERMINATION OF TEST INSTRUMENTS AND DEVICE UNDER TEST**

MAXIMUM POWER INPUT: 1/2 W
WEIGHT: 2.5 Ounces typical

OFFSETS

Model	Freq. Range (GHz)	Connector	Return Loss	
			40 dB ± 0.7 dB to 2.0 GHz ± 1.5 dB to 8.0 GHz	
			20 dB ± 0.5 dB to 1.0 GHz ± 1.0 dB to 4.0 GHz ± 1.5 dB to 18 GHz	

OFFSETS PROVIDE REFERENCE OFFSET FOR MEASUREMENT OF LOW SWR OR HIGH DIRECTIVITY.

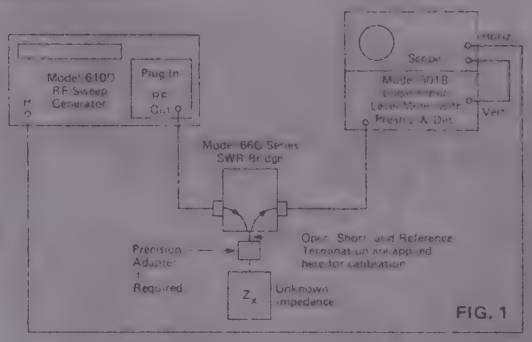
to the Error Averaging Method in that airline ripple techniques are used and accordingly, it is limited to measuring devices with uniform characteristics. It accomplishes measurements to 60 dB without requiring pre-amplification before log conversion.

Direct Measurement Method (1)

This measurement method utilizes the direct readout of a high-directivity bridge. Bridges with 60 dB directivity are used so that measurements can be made to 40 dB return loss with less than 1 dB error. Precision adapters can be applied to the bridge test port to enable measurements with various types of test connectors. The logarithmic level meter permits direct readout in dB return loss.

This method may be used with both wide band and narrow band measurements. Direct measurements may be conducted to 50 dB return loss with reduced accuracy if a preamp is used with the logarithmic level meter.

The recommended Wiltron test equipment for this measurement is as follows: ■ Model 610D Sweep Generator with RF Plug-In, ■ Model 66G Series SWR Bridge, ■ Model 26 or 28 Series Precision Termination, ■ Model 32 or 34 Series Precision Adapters (if required), ■ Model 23 Series Reference Short, ■ Model 501 with Model 73 Series RF Detector or 501 B Logarithmic Level Meter (Model 501 B contains a preamplifier to permit measurements of very low reflection), and ■ Oscilloscope.


Model 610D RF Sweep Generator
Plug-In RF Out
Model 66G Series SWR Bridge
Precision Adapter (if Required)
Open, Short and Reference Terminations are applied here for calibration
Z_x
Unknown Impedance
FIG. 1

Other measurement methods are discussed on the next pages.

75 ohm SWR Bridges & References

66G75 SERIES – PRECISION SWR BRIDGE Measures SWR to 1.002 (with internal 75 ohm reference terminations)

Model	Freq. Range (MHz)	Directivity (dB)	Connector	*Accuracy	
66G75A	5-50	60	GR900, 75Ω	.001 ± 0.09ρ^2	
66G75B	50-200	60	GR900, 75Ω	.001 ± 0.09ρ^2	
66G75V	200-400	60	GR900, 75Ω	.001 ± 0.10ρ^2	
66G75U	400-1000	60	GR900, 75Ω	.001 ± 0.11ρ^2	
66G75L	1000-2000	52	GR900, 75Ω	.0025 ± 0.10ρ^2	

*Where ρ is the reflection coefficient being measured.

SWR BRIDGE MODEL 66G75U

INPUT/OUTPUT CONNECTORS: Type N Female Stainless Steel
INSERTION LOSS: 6.5 dB nominal (from input to test port)
MAXIMUM POWER INPUT: 1/2 W
WEIGHT: 14.5 Ounces (typical)
DIMENSIONS: 4" x 2-1/2" x 1-3/4" (typical)

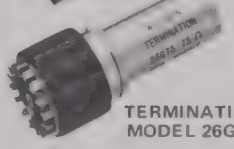
TERMINATIONS

Model	Freq. Range (GHz)	Connector	SWR (F in GHz)	
26G75	DC to 8.0	GR900	1.002 + 0.002F	
26N75	DC to 8.0	N Male	1.002 + 0.003F	
26NF75	DC to 8.0	N Fem.	1.002 + 0.003F	
26B75	DC to 2.0	BNC Male	1.002 + 0.004F	
26BF75	DC to 2.0	BNC Fem.	1.002 + 0.004F	
26SF75	DC to 4.0	*SJ-F	1.002 + 0.004F	
26SC75	DC to 2.0	*SC	1.002 + 0.004F	

*Common connectors used in Japan.

TERMINATION MODEL 26BF75

TERMINATION MODEL 26G75



TERMINATIONS:
- AVAILABLE WITH COMMONLY USED CONNECTORS
- TERMINATION RESISTORS ARE AGED FOR LONG-TERM STABILITY
- PROVIDE ACCURATE REFERENCE FOR SWR MEASUREMENTS

WEIGHT: 3 Ounces (typical)

OFFSETS

Model	Freq. Range (GHz)	Connector	Return Loss	
21-4	DC to 8.0	GR900	4 dB ±0.7 dB to 2.0 GHz ±1.5 dB to 8.0 GHz	

OFFSETS PROVIDE REFERENCE OFFSET FOR MEASUREMENT OF LOW SWR OR HIGH DIRECTIVITY.

SHORTS For use in 50 and 75 ohm systems

Model	Freq. Range (GHz)	Connector	
21A	DC to 8.0	APC7	
21G	DC to 8.0	GR900	

SHORTS ARE USED ON THE TEST PORT OF AN SWR BRIDGE, SWR AUTOTESTER, DIRECTIONAL COUPLER, OR SLOTTED LINE TO ESTABLISH A FULL REFLECTION REFERENCE.

Error Averaging Measurement Method (2)
(Return loss measurements from 0 to 54 dB)*

This method measures the unknown through a length of precision air line. By sweeping over a wide frequency range, the air line causes the unknown signal to interact with the residual error of the measurement bridge in a periodic manner (see figure 2). This permits the unknown signal to be separated for measurement purposes from the residual error of the bridge, enabling accurate measurements to 54 dB return loss.

By averaging through the ripple pattern, the primary effects of directivity and test port match errors may be eliminated.

As to this method, the unknown being measured must be restricted to those items having wide band performance and those having return loss characteristics that are smoothly varying with frequency. Furthermore, the method is frequency-limited to frequencies high enough to permit several cycles of ripple to be produced in the swept frequency range. For the 50 ohm air line, with a 68 cm length, measurements may be made from 400 MHz to 18 GHz. The 75 ohm version covers 400 MHz to above 2 GHz. This method is suitable for checking terminations, precision pads, and precision adapter pairs, etc.

By reversing the technique, a reference offset termination of 40 dB may be applied at the end of the air line, permitting the convenient measurement of the directivity of a precision bridge to 60 dB.

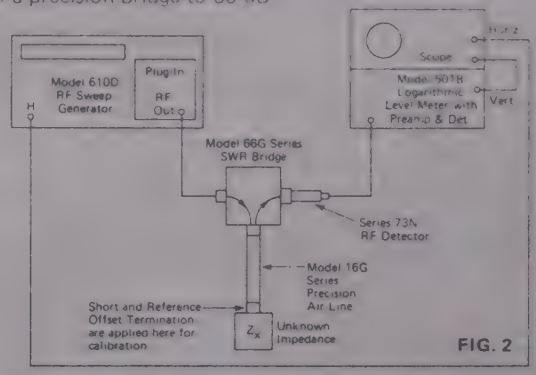
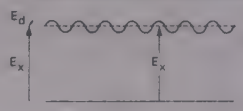


FIG. 2



Interaction of directivity signal E_d with unknown E_x facilitated by the precision air line permits interpreting through the ripple to the desired measurement of E_x.

*See "A Precision Swept Reflectometer" by Dr. Peter Lacy and William Oldfield, Microwave Journal, April, 1973.

Model 58A50 SWR Bridge in Magnified Measurement System

The Model 58A50 SWR Bridge makes it possible to achieve accurate measurements of SWR as low as 1.006. When used with the Model 18A50 Precision Air Line and Model 29A50-20 Reference Offset in the Magnified Measurement System (Fig. 3), the equivalent directivity is extended to 60 dB, permitting accurate measurements of very small reflected signals.

SYSTEM ACCURACY:

0.001 $\pm 0.015\rho^2$, 2.0 to 12 GHz
(equivalent to 60 dB directivity)
0.0018 $\pm 0.02\rho^2$, 12 to 18 GHz
(equivalent to 50 dB directivity)

Air Lines

Precision Air lines provide both a standard impedance and a time delay for use in the Averaging Measurement System and the Magnified Measurement System.

A beadless connector is used at the measurement end to provide a minimum reflection connection. The other end is beaded to keep the center conductor captive, thus fixing the plane of reference at the beadless end.

50 OHM AIR LINES

Model	Freq. Range (GHz)	Connector	SWR	Dia. (mm)	Length (cm)	
18A50	0.4 to 8.0	GR900	1.002	14	67.8	
18A50	2.0 to 18	APC 7	1.002	7	30	
18A50	2.0 to 18	N Male or Female	1.004	7	30	

75 OHM AIR LINES

Model	Freq. Range (GHz)	Connector	SWR	Dia. (mm)	Length (cm)	
16G75	0.4 to 8.0	GR900	1.002	14	67.8	

PRECISION AIR LINE
MODEL 18A50

- **Gold over silver plating is essentially lossless**
- **Impedance established by mechanical dimensions**
- **Makes possible SWR measurement of 1.006 to 18 GHz when used with Model 58A50 SWR Bridge and Model 29A50-20 Reference Offset.**

PRECISION AIR LINE
MODEL 16G75

The only additional equipment required, compared to Method 1, is a WILTRON Model 16 or 18 Series Precision Air Line and Model 27 or Model 29 Series Offsets. (See Fig. 2)

Magnified Measurement Method (3)

(Return loss measurements from 26 to 60 dB)

This method, like the Error Averaging Method, also measures the unknown through a length of precision air line. However, the Magnified Method offsets the bridge directivity to a value less than the return loss to be measured. This requires a 4-port bridge with an offset on the reference port. Then the swept response displays "Magnified Return Loss" in the form of a ripple variation on the offset return loss. The high return loss (low reflection) may be simply determined by measuring the offset value and the peak-to-peak ripple. As the response is about the offset signal level, the measurement of low SWR's is facilitated by measurement at a higher RF signal level.

With a termination on the reference port, this method becomes the same as the Error Averaging Method, and measurements to 26 dB are conducted.

With an offset on the reference port, the measurements shift to the range of 26 dB to 60 dB. Using this method, the limiting error is primarily the impedance of the air line rather than the directivity of the bridge.

A reference offset termination of 20 dB may be applied at the end of the air line to permit the accurate measurement of the directivity of a precision bridge to 46 dB.

This test setup shown in Fig. 3 uses the same equipment as Fig. 2 except the Wiltron Model 58A50 SWR Bridge has been substituted for the Model 66G Series SWR Bridge.

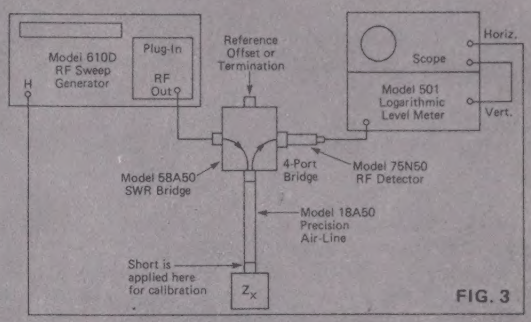


FIG. 3

Adapters

This series of adapters enables accurate measurements with a variety of connector type interfaces. They are designed around the precision GR900 and APC-7 connectors which are also used as test port connectors on the Precision SWR Bridges. Each adapter is fully specified and 100% tested to assure optimized performance over the specified frequency range.

The selection of precision adapters is extremely important for accurate measurements as the adapter affects the measurement accuracy in two ways. The effective directivity of the measurement device is reduced because of the reflection from the adapter, and the test port match is degraded as well. By careful design and meticulous construction, WILTRON has minimized these affects. Using WILTRON Precision SWR Bridges and Precision Adapters, accurate measurements can be made of SWR's of less than 1.01.

50 OHM ADAPTERS

Model	Frequency Range (GHz)	Connectors	SWR (F in GHz)
32GN50	DC to 8.0	GR900-N Male	1.004 + 0.004F
32GNF50	DC to 8.0	GR900-N Female	1.004 + 0.004F
32GB50	DC to 2.0	GR900-BNC Male	1.004 + 0.01F
32GBF50	DC to 2.0	GR900-BNC Female	1.004 + 0.01F
34AN50	DC to 18	APC-7-N Male	1.01 to 8.0 GHz 1.02 to 18 GHz
34ANF50	DC to 18	APC-7-N Female	1.01 to 8.0 GHz 1.02 to 18 GHz
34NN50	DC to 18	Beadless N Male-N Male	1.02
34AS50	DC to 18	APC-7-SMA Male	1.055 to 12GHz 1.07 to 18 GHz
34ASF50	DC to 18	APC-7-SMA Female	1.055 to 12GHz 1.07 to 18 GHz

50 OHM ADAPTER
MODEL 34AN50

- LOW SWR TO 18 GHz
- PROVIDE CONVENIENT TRANSITIONS IN MICROWAVE MEASUREMENT SETUPS WITH MINIMAL DEGRADATION OF SPECIFICATIONS
- LOW INSERTION LOSS
- COMMON CONNECTOR TYPES

WEIGHT: 3.25 Ounces (typical)

75 OHM ADAPTERS

Model	Frequency Range (GHz)	Connectors	SWR** (F in GHz)
32GN75	DC to 8.0	GR900-N Male	1.003 + 0.004F
32GNF75	DC to 8.0	GR900-N Female	"
32GB75	DC to 2.0	GR900-BNC Male	1.003 + 0.004F
32GBF75	DC to 2.0	GR900-BNC Female	"
32-5CP	DC to 2.0	GR900-5CP*	1.003 + 0.004F
32-5CJ	DC to 2.0	GR900-5CJ*	"

75 OHM ADAPTER
MODEL 32GNF75

- PERMIT PRECISION MEASUREMENTS IN 75Ω SYSTEMS
- EXCEPTIONALLY LOW SWR
- LOW INSERTION LOSS
- COMMON CONNECTOR TYPES

WEIGHT: 3.25 Ounces (typical)

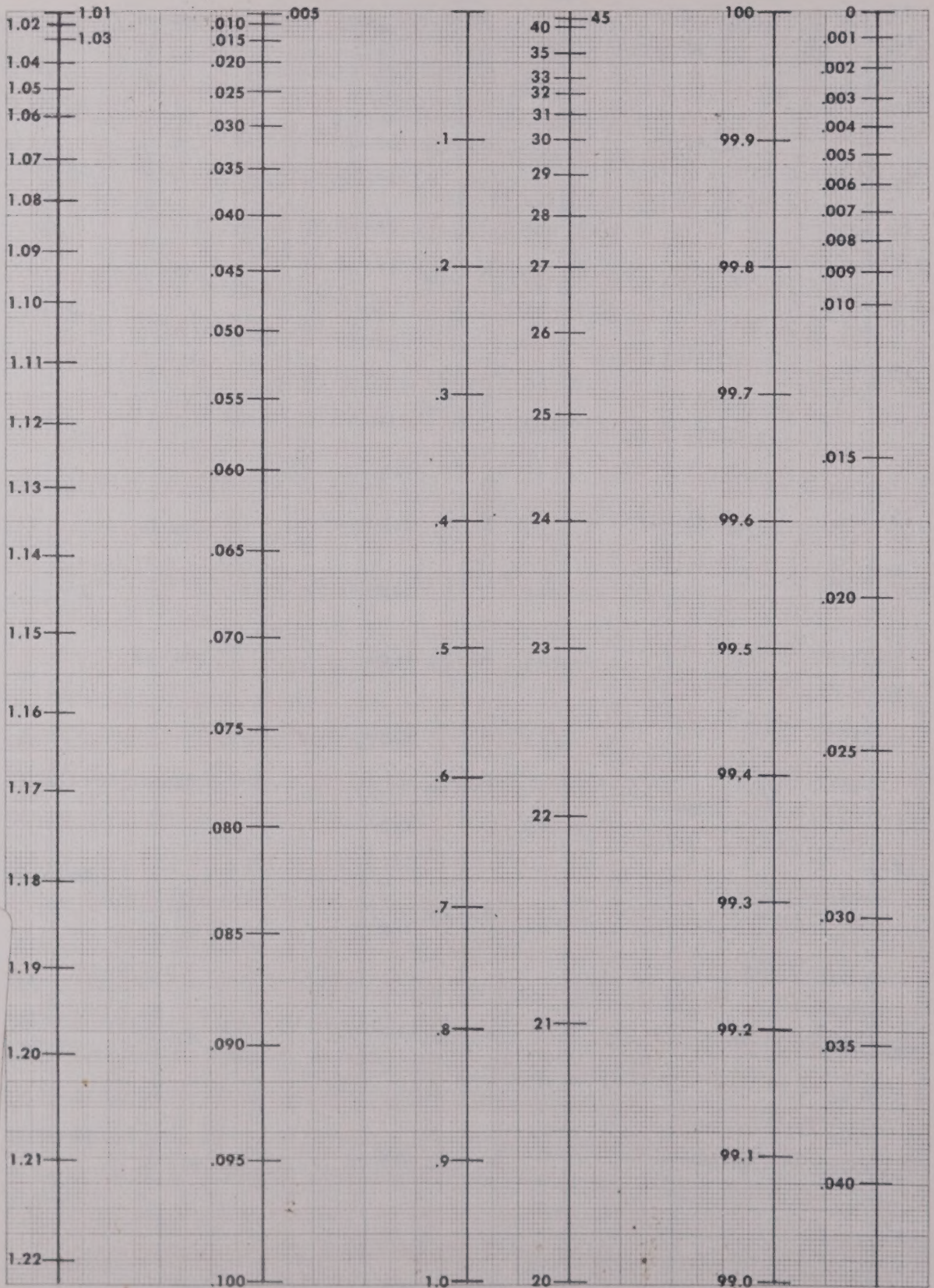
*Common connectors used in Japan.
**The SWR specified applies to a mated pair or to one adapter and a reference termination for the connector listed.

SECTION VI
SWR NOMOGRAPHS

6-1 GENERAL

The following pages contain SWR nomographs to facilitate conversion of SWR readings to return loss, reflection coefficient, percentage of power reflected, percentage of power transmitted, and transmission loss in dB.

SWR NOMOGRAPH # 3



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